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DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

THE U. S. NATIONAL HERBARIUM.

Vol. V, No. 1.

1533

ISSUED JANUARY 25, 1897.

GENERAL REPORT ON A BOTANICAL SURVEY OF THE CŒUR D'ALENE MOUNTAINS IN IDAHO DURING THE SUMMER OF 1895.

BY

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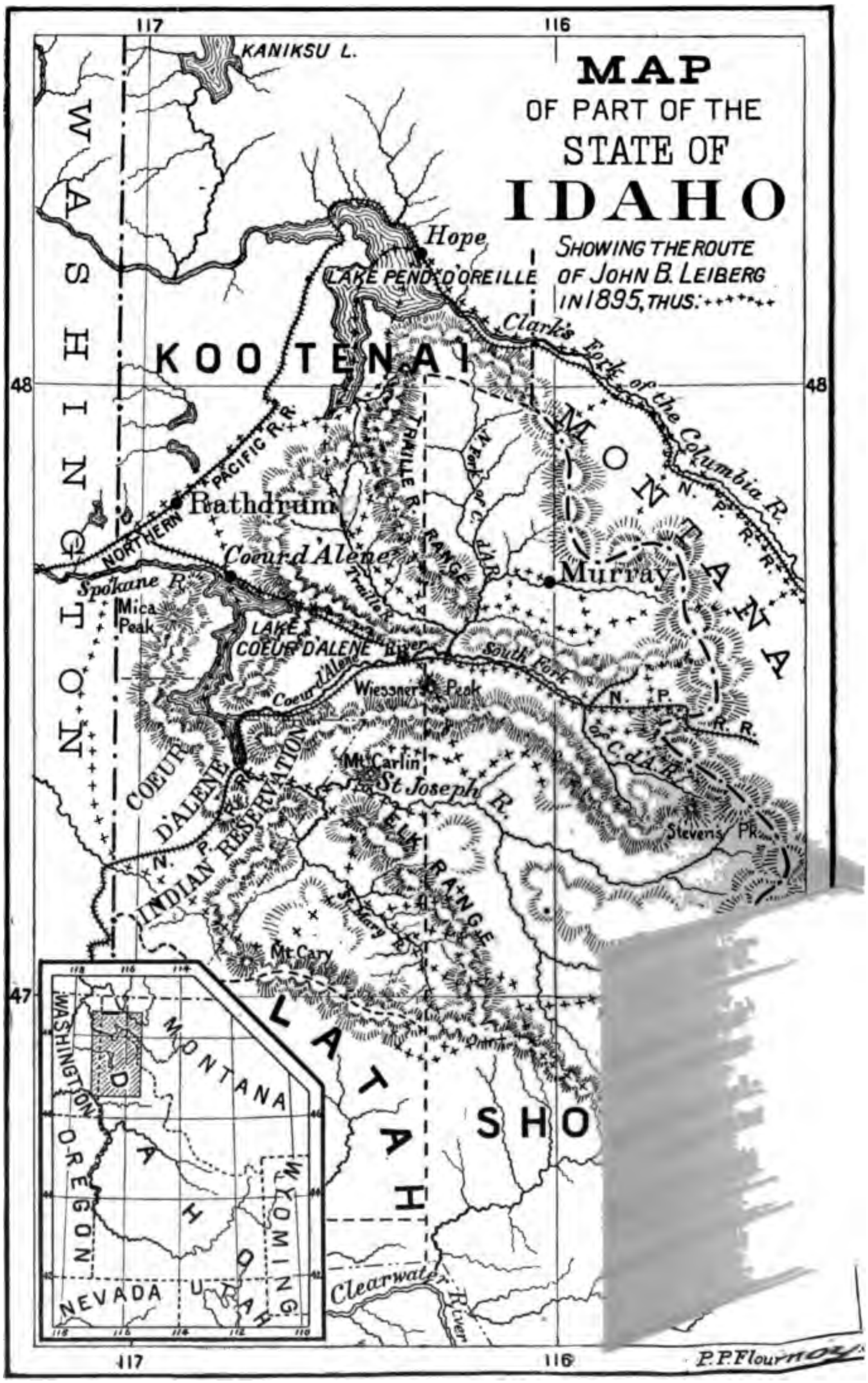

MAP OF NORTHERN IDAHO.

U. S. DEPARTMENT OF AGRICULTURE.
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BY

JOHN B. LEIBERG.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Botany,
Washington, D. C., November 13, 1896.

Sir: I have the honor to transmit herewith for publication as one of the Contributions from the United States National Herbarium a manuscript entitled General Report on a Botanical Survey of the Cœur d'Alene Mountains in Idaho during the Summer of 1895, prepared by Mr. John B. Leiberg, a field botanist of this Department.

The technical portion of the report it is not desirable to publish at this time.

Respectfully,
Frederick V. Coville,
Botanist.

CONTENTS.

Page.

Introduction, by Frederick V. Coville 1

GENERAL REPORT ON A BOTANICAL SURVEY OF THE CŒUR D'ALENE MOUNTAINS IN IDAHO DURING THE SUMMER OF 1895. By John B. Leiberg...... 5

Itinerary 5

Topography 6

Drainage 10

Climate 13

Mineral deposits 22

Agricultural capacity 25

Agricultural products 29

Grazing lands 31

Native food plants 37

Utilization of water supply 38

- Milling and logging 39
- Mining 40
- Irrigation 40

Forest resources 42

- Yellow pine (*Pinus ponderosa*) 43
- White pine (*Pinus monticola*) 45
- Black pine (*Pinus murrayana*) 46
- White-barked pine (*Pinus albicaulis*) 46
- Engelmann spruce (*Picea engelmanni*) 47
- White fir (*Abies concolor*) 48
- Subalpine fir (*Abies lasiocarpa*) 49
- Tamarack (*Larix occidentalis*) 50
- Hemlock spruce (*Pseudotsuga taxifolia*) 50
- Cedar (*Thuja plicata*) 51
- Patton's hemlock (*Tsuga pattoniana*) 53
- Mertens's hemlock (*Tsuga mertensiana*) 54
- Yew (*Taxus brevifolia*) 54
- Red cedar (*Juniperus virginiana*) 55

Forest zones 56

- Zone of yellow pine 58
- Zone of white pine 59
- Zone of sulbalpine fir 59
- Zone of white-barked pine 60

Forest destruction 61

Burned areas 71

Forest preservation 75

A new system of timber protection 79

ILLUSTRATIONS.

Plate I. Map of northern Idaho .... Frontispiece.

INTRODUCTION TO THE REPORT ON THE CŒUR D'ALENE MOUNTAINS.

From the appropriations made for botanical investigations and experiments a portion has been devoted annually during the past four years to an examination of the botanical resources of certain little-known portions of the United States. Reports on some of these investigations have already been published. The one now transmitted deals with that portion of the Bitter Root Mountains of northern Idaho known as the Cœur d'Alenes, a fairly representative part of the whole range, and as the region is heavily timbered the economic part of the report necessarily deals largely with trees.

Mr. Leiberg's instructions from the Botanist were substantially as follows:

> The region in which you will be engaged is the Cœur d'Alene Mountains of northern Idaho and as much of the adjacent country as you find time to explore in addition to ascertaining the facts called for in these instructions.
>
> Your work will cover the following subjects: (1) A collection of all the species of plants in the region traversed; (2) a general account of the topography and climatic conditions of the region; (3) the timber resources of the country and its relation to other local industries; (4) the local and aboriginal uses of native plant products, particularly food plants, and (5) an analysis of the flora of the region into its several component floras, in their relation particularly to topographic and climatic conditions.
>
> * * * * * * *
>
> You will report the number and size of the streams flowing from the Cœur d'Alene Mountains and to what extent they are used for irrigation. You will ascertain as nearly as may be the rainfall in various parts of the range, and secure, if possible, data on the temperature and prevailing winds, particularly with reference to the source of rainfall.
>
> Under timber resources, you will ascertain the size, kinds, and amount of timber, by localities, and its accessibility to streams or other means of transportation. You will ascertain whether stock is ranged in the forests, and whether sheep alone, or cattle and horses in addition, comprise the stock so ranged. You will ascertain whether valuable mineral deposits have been discovered in the forest area, and whether they are actually being worked at the present time. You will also, if practicable, make measurements of particular trees, to give a fair idea of the size of each kind of timber. * * *
>
> You will ascertain, so far as possible, what plants have been used for food by the aboriginal tribes, and will collect herbarium specimens of the plants themselves, together with specimens of the food products, in various stages of preparation, as

they are now used or have been used by the Indians. Whenever possible, you will also make any other notes of importance relative to the aboriginal uses of plants for fiber, basket materials, or medicines.

In connection with the subdivision of the flora into its component floras, you will also note what cultivated plants are peculiarly adapted or restricted in their occurrence to each natural belt or zone.

You will collect data which will enable you to plat upon a map the area of commercial timber, of scattered timber, and of timberless land in the region examined. You will plat your route accurately upon the map.

You will also indicate upon the map, by political subdivisions, if possible, and in other cases by natural boundaries, such areas as, in your opinion, are desirable and suitable for timber reservations in relation to the demands for timber in local industries and the preservation of water supply of the adjacent country, leaving out of the reservation all agricultural lands.

You will indicate what regulations, if any, are necessary to secure the proper use of timber for mining or agricultural purposes within any portion of the proposed reservation.

The present report contains a larger amount of information regarding the region than would be possible in the case of an ordinary investigation. Mr. Leiberg has lived in northern Idaho for about ten years, and during this period has often visited the Cœur d'Alenes, sometimes remaining there for several months at a time. His report, therefore, is the result of a large amount of observation and experience.

In the report as now transmitted a statement of Mr. Leiberg's recommendations relative to timber reservations is not included. Since the report was written Congress has made an appropriation for a Forestry Commission, one of whose duties is to consider the general question of timber reservations. This part of Mr. Leiberg's report, therefore, has been withheld from publication for the present, and will be placed at the disposal of the Commission.

The discussion of the mineral resources of the region is more elaborate than would be necessary in an ordinary report on botanical resources, but a reasonably full treatment is required in the present case to show the scope and importance of the mining industries of the Cœur d'Alenes, for this industry must be taken into full consideration if any provision is made hereafter for State or Governmental management of these forests.

The discussion of the climate, also, is given in considerable detail, as in case of a future selection of any portion of this region for timber reservations all possible knowledge of its climatic conditions will be valuable.

The report shows that the region is one of extremely heavy rainfall compared with that of other localities so far from the Pacific coast, and that in consequence of this rainfall a heavy growth of timber covers most of the region. The agriculture of the country amounts to almost nothing except in some of the lower valleys, and even there it is chiefly confined to grazing. The principal industries are mining and lumbering, and it is in relation to these that the vegetation of the region, from economic standpoint, must be considered. In the future, however, it is possible that the subject will have an important bearing on the irrigation of the plains lying farther to the west, for their natural water supply comes from the Cœur d'Alenes.

One of the principal practical lessons brought out in the report is the extent to which forest destruction may be carried in the absence of any efficient legal or commercial check. The era of forest fires began in the earlier period of immigration, followed by the destruction incident to the building of the Northern Pacific Railroad and in very recent times by the unparalleled devastation connected with the mining industry. In this connection I may quote the following from Mr. Leiberg's report:

> The next and last stage in the destruction of the forests, which is still in active operation, came when the great ore deposits in the Cœur d'Alenes were discovered. Thousands of prospectors flocked into the country then, and the forest fires raged in hundreds of localities to clear away the dense growth of timber and shrubs, which very materially interfered with the work of the prospectors seeking the mineral-bearing lodes. As the mines began to develop, fuel and timber were needed. The choice parts of the forest were cut into, débris took the place of the green tree, and fire coming later, finished what the ax had spared. In 1884 I passed through the Cœur d'Alenes into Montana. In spite of the many previous fires, there were miles upon miles of primeval forest. In this year (1895) along the same route there was not a single foot that the fire and ax had not run through, and the larger quantity had been uselessly and totally destroyed.

The result of all these sources of forest destruction is expressed in another statement of Mr. Leiberg's, as follows:

> From an intimate knowledge of the Cœur d'Alenes, obtained during a residence of ten years in the immediate neighborhood, I do not hesitate to affirm that 50 per cent of the accessible merchantable timber of the Cœur d'Alenes is absolutely destroyed; that of the remainder, 20 per cent has been more or less culled, leaving only 30 per cent in good condition. All this within a period of thirty-four years, and of these, only twelve years represent settlement and development.

At the end of his report proper on the Cœur d'Alenes Mr. Leiberg outlines a system of timber protection drawn from his experience of the region, of the people, and of the local industries. It is a suggestive circumstance that the system proposed is similar in many respects to that outlined in the Paddock bill, presented to Congress in the year 1892, a bill with which Mr. Leiberg was not acquainted at the time his report was submitted. If essentially the same system suggests itself on the one hand to students of the general forestry question in the east and on the other hand to a practical observer in the field, it indicates that that system is worth the careful consideration of our law-making bodies. There can be little doubt that a system similar to the one here outlined would be a great step in advance upon the special agent system which the Department of the Interior is now compelled by law to follow.

FREDERICK V. COVILLE,
Botanist.

GENERAL REPORT ON A BOTANICAL SURVEY OF THE CŒUR D'ALENE MOUNTAINS IN IDAHO DURING THE SUMMER OF 1895.

By JOHN B. LEIBERG.

ITINERARY.

In compliance with instructions from the Botanist of the Department of Agriculture, dated June 3, 1895, to make a botanical survey of the Cœur d'Alene Mountains in northern Idaho with special reference to the economic features of the flora, I left Hope, Idaho, on June 11.

The field work was begun in the middle portion of the St. Mary basin, thence carried to the upper part of this stream, and extended along the divide between the St. Mary, St. Joseph, and the North Fork of the Clearwater, taking in as much of the densely timbered portion of the West and East forks of the St. Joseph as time permitted.

After finishing here, the work was gradually extended northward, and terminated with the exploration of the extreme western portion of the North Fork of the Cœur d'Alene River basin, in the middle of October.

The time actually spent in the field was divided between the various sections as follows: June 15 to July 6 was devoted to the central portion of the St. Mary basin and about the head waters of this stream. July 6 to July 14 was given to the summit of the high ridges which separate the St. Joseph's tributaries from the North Fork of the Clearwater and to the divides between the upper portions of the forks of the St. Joseph. From the 14th to the 17th of this month the work was in the lower part of the St. Joseph valley. From the 17th of July to the 7th of August I was engaged in the valley of the South Fork of the Cœur d'Alene River, with frequent side trips to the summits of the divides which separate this stream from the St. Joseph and into the valleys of the more eastern tributaries of the latter, which could not well be reached from the upper St. Mary. From August 7 to August 13, I was employed in examining the eastern rim of the basin of the North Fork of the Cœur d'Alene River. The time from August 17 to September 1 was spent in the valley of the Clark Fork of the Columbia, from the first easterly crossing of this stream of the Northern Pacific

Railroad to Cabinet Rapids, examining the northern rim of the mountains which inclose the North Fork of the Cœur d'Alene River. September 4 to September 19 was employed partly along the western rim of the North Fork basin and partly in making a second ascent of Wiessner Peak to obtain some meteorological data during the early snowstorms of the season. September 25 to October 9 was employed in a trip into the more western portion of the North Fork basin to obtain more data concerning the forest conditions of this particular region. With this the field work of the season ended.

TOPOGRAPHY.

The extent of country to which the name Cœur d'Alene should be applied has heretofore been rather indefinite. The common view limits it to the region drained by the South Fork and a small portion of the North Fork of the Cœur d'Alene River. By reason of the great mining industries which are carried on here these areas are by far the most important and most widely known of all in the Cœur d'Alene Mountains, and therefore are usually meant when the Cœur d'Alenes are spoken of. A broader view is here adopted, and one more in harmony with the geographical position of the region and its geological relations to the surrounding mountains, as well as with its peculiar and intricate topography, which latter feature very decidedly stamps the areas we shall here include under the general name Cœur d'Alenes as parts of one mountain system.

The Cœur d'Alenes, therefore, are here understood to include all the mountains or ridges, exclusive of the main Bitter Root Range, which form the drainage system of the streams flowing into Lake Cœur d'Alene. The geographical position of the region is between 115° 20′ and 116° 40′ west longitude, and between 46° 40′ and 48° 40′ north latitude, approximately.

Politically it is included within the boundaries of Kootenai and Shoshone counties, in Idaho, and its area may be roughly estimated at 9,000 square miles.

The Cœur d'Alene Mountains form in general a rugged and difficult region. The system is not what is generally understood as a range, though many of the maps, especially the older ones, so delineate it. There is no general "backbone" traversing the area and sending out laterals each way. All the larger ridges and principal divides join with the Bitter Root Range eventually, and but for the peculiar manner in which they extend and inclose the drainage basins of the river systems might be regarded as simply an immense western foothill region of the Bitter Root Mountains. The entire extent of country here called the Cœur d'Alenes forms a large, almost completely inclosed, triangular area. The apex of this triangle may be considered as abutting on the Clark Fork River at Cabinet. From this point the eastern side of the triangle, which has a length of about 190 kilometers (111 miles), is formed by the main range of the Bitter Roots.

The southern base of the triangle is formed by a high, nearly due east and west ridge, which divides the waters of the North Fork of the Clearwater from the Cœur d'Alene drainage system. This is about 160 kilometers (99 miles) in length. The western termination of this ridge s a heavily forested, quite conspicuous mountain, to which the name "Mount Carey" is sometimes applied. It forms the central knob of an extensive group of radiating ridges, among which lie the headwaters of the Potlatch and those of one of the principal tributaries of the Palouse. Its elevation is about 1,520 meters (5,000 feet).

The western side of the triangle, commencing at this mountain, extends northward a distance of 105 kilometers (65 miles), where a gap or break occurs. In this gap is situated a part of Lake Cœur d'Alene, a great natural reservoir, into which flows all the water discharged by the streams of the interior drainage basins of the Cœur d'Alenes. Commencing directly to the north of this lake, the western mountain rim resumes its extension northward, passing a few kilometers to the east of Lake Pend Oreille and joining the Bitter Roots at Cabinet, to form the apex of the Cœur d'Alene triangle, a distance of about 95 kilometers (59 miles).

The mountain rims which form the sides and base of this triangle are not to be regarded as straight and regular lines. On the contrary, they are extremely serpentine in their course, swinging often from east to west and from north to south, and vice versa, many kilometers from a straight line.

This twisting and turning of the divides with the numerous deep saddles and corresponding rises render the heavily timbered portion of the crest line of these ridges very difficult to follow.

From every rise or peak an extensive system of laterals is sure to radiate, and in every saddle a stream heads on each side of the ridge, so that unless the traveler knows the way, or is exceedingly careful, he is constantly in danger of being led off on these lateral ridges or into the side ravines from the main divide which he may be endeavoring to follow.

The region inclosed by the three mountain rims just described, is exceedingly rough and broken. It is a mass of long, steep, tortuous ridges, inclosing a multitude of deep, narrow canyons. The elevation of the ridges varies from 1,350 to 2,160 meters (4,400 to 7,000 feet), the average being about 1,500 meters (5,000 feet).

It is a remarkable fact that the highest elevations in the Cœur d'Alenes are not found in the main range of the Bitter Roots, but lie about 65 kilometers (40 miles) to the west in the divide which separates the waters of the Cœur d'Alene River from those of the St. Joseph. Here the ridge rises in a few localities to a height of 2,175 meters (about 7,100 feet).

There is also situated on the western mountain rim of the triangle, about 32 kilometers (20 miles) south from Cabinet, a mountain locally known as Pack Saddle. This has an elevation of about 2,400 meters

(7,900 feet), and is therefore probably the highest point in the Cœur d'Alene region.

The definite details of the configuration of the mountain system of the Cœur d'Alenes are almost impossible to describe in terms that will present a true picture to one personally unacquainted with the region. There are, however, certain features which appear in all portions of the system and which give to the whole a determinate character. We have first the very long, tortuous ridges extending from all sides of the inclosing mountain rims into the interior of the Cœur d'Alene basins. The sinuosities of these ridges are a repetition of those of the primary inclosing divides, but on a smaller scale. We have next the wavy crest line of the ridges, caused by a continual succession of saddles and the opposite rises. A level crest line for a greater distance than one kilometer is a rarity. We have next the system of lateral spurs radiating from the rises and peaks of the ridges, and the ravines which invariably head on opposite sides of the saddles. The features of wavy crest lines and lateral ravines and spurs heading in the saddles and rises are repeated over and over again to the very smallest spur of the system. It is this continual division and subdivision of the long laterals, sent out from the primaries, that give the Cœur d'Alenes the peculiar broken character which is such a distinguishing feature of their system.

The laterals, where they abut upon the larger valleys, terminate mostly in two ways—first, as a slender, low, attenuated point of rocks; secondly, and by far the most often, as a broad front more or less cut into by short ravines. The width of the base of the fronting part of the spur is approximately equal to the length of spread of all its lateral extensions. This feature is exceptionally well developed in the North Fork basin, and occurs there with great regularity.

The peaks, so called, of the Cœur d'Alenes are not exactly the form of mountain we are accustomed to call peaks. They are, in the majority of instances, simply the rising swells of the ridge between the saddles. Now and then a rocky eminence occurs which crowns the junction of several great radiating spurs, and rises perhaps 200 to 300 meters (650 to 1,000 feet) higher. In such cases they assume more truly the shape we are used to associate with that word. One of the best examples of the class is Wiessner Peak, situated on the divides between the South Fork of the Cœur d'Alene and the St. Joseph. The ridges of the Cœur d'Alenes are usually very steep, an angle of 40° being common. Along the higher divides are many localities where the slopes run up to 60° and even 70°. Perpendicular cliffs occur here and there. They are most numerous near the main range of the Bitter Roots and along the Clearwater divide. They are seldom over 250 meters (or about 820 feet) in height. An exception is found on the western slope of the ridges which form the western side of the Cœur d'Alene triangle. At the south end of Lake Pend Oreille are precipices having a slope of over 80° and a height of 850 meters (or about 2,800 feet). There are more precipitous stretches on the larger east and west ridges than elsewhere, and they are almost invariably on the northern slopes. The reason for this appears to be that these divides are situated along great faulting lines. Notwithstanding the steepness of the ridges, they do not commonly present rocky sides. The solid bed rock of the country is more frequently deeply covered with débris and soil than exposed. The ravines are tortuous and narrow. Even the longest valleys are comparatively narrow when one considers the great number of side ravines which open into them. A width of 3.2 kilometers (2 miles) is a rarity, and is reached only in the slackwater portion of the valleys of the Cœur d'Alene and St. Joseph rivers. The average width of the valleys of the principal streams is about 1 kilometer (or about five-eighths of a mile). The width of the lateral ravines varies so much that no average can be given. It will often not exceed 10 to 15 meters (33 to 49 feet), with the ridges rising 300 to 500 meters (1,000 to 1,600 feet) above the floor of the ravine. Such narrow places are deprived of the direct sunlight during several months of the year.

The geological formations of the region are wholly composed of nonfossiliferous rocks. In the southern portion micaceous, granitic, feldspathic, and syenitic rocks abound. The southern base of the Cœur d'Alene triangle is almost wholly composed of these primary rocks. In the middle and lower portions of the St. Mary and St. Joseph there are large areas covered with basaltic outflows, which connect to the northward, near Lake Cœur d'Alene, with the basaltic rocks of the plains of the Columbia. The central and northern portions of the region have less of the primary rocks exposed. The prevailing formations here are siliceous magnesian schists, great masses of ferruginous quartzite, and here and there dolomitic and calcareous rocks. These two latter classes of rocks are especially abundant near Lake Pend Oreille, along the more northern portion of the western mountain rim, and appear to be the final southeasterly extension of the dolomitic rocks, which abound northwesterly toward the Colville region. The basaltic rocks are absent in the country north and northeast of Lake Cœur d'Alene, except over a small area which extends 10 kilometers (6 miles) northeast from the lake. The magnesian schists are frequently traversed by various kinds of igneous dikes. This is especially the case in the basins of the North and South forks of the Cœur d'Alene River. The quartzite rocks of the Cœur d'Alenes are prominent features in the geology of the country.

The thickness of the bedded rocks of the Cœur d'Alenes can not be told with absolute certainty. It is, however, not less than 3,000 meters (or about 9,860 feet). These figures have been computed from a careful measurement of the exposures of bedded rocks which occur along the east shore of Lake Pend Oreille and in the North Fork basin.

The geological age to which they belong has, to my knowledge, never been determined. As before remarked, they are strictly nonfossiliferous. Judging from this fact and taking into consideration their highly metalliferous character, as well as the position, extent, contents, and general appearance of the mineral-bearing lodes which traverse them, I am inclined to place them among the pre-Cambrian rocks of the continent.

DRAINAGE.

The drainage system of the Cœur d'Alene basins is composed of two principal water courses, which divide and subdivide over and over again and form that most intricate system of lateral streams, some of them of considerable size, which is such a prominent feature of the region.

The primary water courses are the Cœur d'Alene and St. Joseph rivers. The waters of these streams flow into Lake Cœur d'Alene, which is thus in a measure a large storage reservoir for the entire drainage from all the interior basins.

The Cœur d'Alene River empties into Lake Cœur d'Alene about 32 kilometers (20 miles) south from the north end of the lake. At a distance of 65 kilometers (40 miles) above its outlet it divides into two streams, the North and South forks of the Cœur d'Alene River. The North Fork, which is the larger stream of the two, heads in the mountains near the north end of Lake Pend Oreille. It flows in an inclosed triangular basin, a repetition on a small scale of the greater Cœur d'Alene triangle. It is very tortuous, and its course on the whole lies near to the eastern side of the triangle; that is, to the main range of the Bitter Roots. Its exact length is unknown, but probably is about 175 kilometers (or nearly 110 miles). The elevation of the valley is about 1,200 meters (3,900 feet) in the upper portion and 670 meters (2,200 feet) at its junction with the South Fork. Near the town of Kingston it breaks through the basal ridge of its basin and effects a junction with the South Fork. It has here a width of about 70 meters (230 feet) and a mean summer stage of water 1 meter (3.3 feet) in depth. The South Fork heads in the ridges of the Bitter Roots a few kilometers to the north of Sohons Pass. Its basin is a rectangular area, its long diameter stretching east-southeast. From its junction with the North Fork to its head in the Bitter Roots is a distance of about 65 kilometers (40 miles). The elevation of its valley at the upper end is about 1,060 meters (3,478 feet) and at its junction with the North Fork about 670 meters (2,200 feet). At the point of junction its width is 30 meters (98 feet), with a summer stage of water of about 75 centimeters (2.5 feet).

In this report, unless especially stated to the contrary, whenever the North Fork or the South Fork is mentioned the respective fork of the Cœur d'Alene River is invariably meant.

The Cœur d'Alene River is navigable in high water from the junction of its two forks to its outlet into Cœur d'Alene Lake, a distance of about 65 kilometers (40 miles). The summer and fall stages of water do not permit navigation farther than to the old Cœur d'Alene Mission.

From this point to Lake Cœur d'Alene, a distance of 48 kilometers (29 miles), the river has an almost imperceptible current and a depth in low water of from 5 to 14 meters (16 to 46 feet). The width of the Cœur d'Alene River at the head of navigation is about 38 meters (125 feet), with a summer stage of water of 2.5 meters (8 feet). The total fall in the river from the head of summer navigation to Lake Cœur d'Alene is only about 5 meters (16.4 feet).

The St. Joseph River is the largest of the Cœur d'Alene streams, and drains the most extensive area. It empties into Lake Cœur d'Alene at the southern extremity, and is navigable for the lake steamers a distance of 42 kilometers (26 miles) from its mouth. The area covered by its basin is trapezoidal in shape. About 24 kilometers (15 miles) from its outlet into Lake Cœur d'Alene it receives its largest tributary, the St. Mary River. About 65 kilometers (40 miles) from its outlet it forks into three streams, two of which head in the ridges which form the divide between the North Fork of the Clearwater and the Cœur d'Alene basin. The third heads in the Bitter Root Range a short distance south of Stevens Peak. This latter is the longest of the tributaries, and might be regarded as the continuation of the main stream. If so, the length of the St. Joseph would be about 220 kilometers (or slightly more than 137 miles).

The elevation of the upper portion of the valleys of the St. Joseph forks is, in the mean, 1,500 meters (4,900 feet), and of the valley at the head of navigation 670 meters (2,198 feet). From the head of navigation to the outlet of the river into Lake Cœur d'Alene there is a fall of about 7 meters (23 feet). The navigable portion of the Cœur d'Alene and St. Joseph rivers is usually called "the slack water."

The St. Mary River, the largest tributary received by the St. Joseph, heads in part in the divide which separates the Clearwater from the Cœur d'Alene basin and in part in the divides in which the Palouse River heads. The upper portion of its valley has an elevation in the mean of 1,050 meters (about 3,400 feet), and the lower, at its junction with the St. Joseph, a height of about 675 meters (about 2,200 feet). It has a width at its junction of about 8 meters (26 feet), and a depth during the summer stage of water of about 3 meters (10 feet).

The lower and navigable portions of these streams all agree in having but a slight fall and a deep channel. This is due to the fact that this portion of their course is cut through a deep diluvial soil, clearly the old bottom of Lake Cœur d'Alene, which, not so very remotely in a geological sense, was far larger and extended well up into what is now in part the valleys of these rivers. Above the slack water the streams are clear, and do not deposit sufficient sediment to fill up the channels. The valleys rise rapidly, the mountains close in, and the current becomes swift, with shallow water during the summer season. The surface water, however, by no means represents the true amount which drains away by these streams. The subsoil in the valleys is a mass of porous gravel, in most places overlying the bed rock to an unknown but certainly very considerable depth. This gravel is very permeable to water, and has everywhere a large underflow.

The multitude of canyons and ravines which branch off from the larger stream valleys in all directions have each a flowing stream at the bottom, which in its turn is supplied by the springs that break out at frequent intervals from the inclosing ridges along their course.

It has already been remarked that Lake Cœur d'Alene receives the entire drainage from the inclosed Cœur d'Alene areas. The outlet of the lake is the Spokane River. This stream is of great commercial importance to a large extent of country by reason of the water power it furnishes at various points. The stage of water in it depends wholly upon the amount of the annual precipitation within the Cœur d'Alene triangle. Owing to the peculiar situation of the lake, it would be possible to hold back a sufficient quantity of water in it to secure a nearly uniform flow in the Spokane throughout the year.

At a distance of 11.5 kilometers (7.15 miles) from the lake down the Spokane River is Post Falls. The stream here cuts through a dike of gneissoid or some other variety of metamorphosed magnesian rocks, and forms a fall of about 12 meters (39 feet) in height. By the cutting through of this dike the lake has been drained from its last high stage of water and the slack-water channels of the rivers of the Cœur d'Alene basins created.

Should it ever become necessary to store a large quantity of water in Lake Cœur d'Alene, it can readily be accomplished by dams at this point, and a nearly uniform stage of water throughout the year be secured for the points below. Such procedure, however, would overflow all the agricultural lands bordering on the slack-water portion of the rivers, as they now have only an elevation of 2 to 3 meters (6 to 10 feet) above *low* water.

The drainage which flows from the Cœur d'Alene Mountains outside the inclosed basins is disposed of as follows: The eastern slopes of the inclosing rims of mountains in the east drain partly into the Missoula River and partly into the Clark Fork of the Columbia by the channels of various small tributaries of these streams. The southern slopes of the divide which forms the base of the Cœur d'Alene system in the south drain in part into the North Fork of the Clearwater and in part directly into the main Clearwater. The western slopes of the northern half of the inclosing west rim drain in part into Lake Pend Oreille; south of the lake, and north of Lake Cœur d'Alene, the drainage flows into the upper Spokane plains and sinks as soon as it reaches these gravel-covered plains to a depth of about 100 meters (325 feet), whence it probably finds its way into the Columbia direct. South of Lake Cœur d'Alene the waters flow partly into Hangman Creek, a tributary coming into the Spokane River just below the city of Spokane, and partly into the Palouse, a tributary of the Snake River.

With reference to the Palouse, it is a curious circumstance that the explorers connected with the surveys for a north transcontinental route in 1853 and 1856 were determined to place the head waters of this stream far enough east to reach the main range of the Bitter Roots. It is so delineated on Governor Stevens's map accompanying his report. Other surveys tried as persistently later on to find a short cut by way of the Palouse to the Missoula River. It appears to have been a slow and difficult task to convince them that the great basin of the St. Joseph with the valley of its tributary, the St. Mary, intervened between the head of the Palouse and the summit of the Bitter Roots. The difficulty probably was due to failure to appreciate the true shape of the peculiar inclosed basins in which the interior drainage of the Cœur d'Alenes flows.

CLIMATE.

The most prominent feature of the climate of the region is its great annual precipitation. Exactly how large this is for all portions of the area we can not say. Meteorological data applying to the uninhabited portions are unobtainable, and they comprise much the larger portion. There are two well-marked periods during the year, a wet and a dry. The dry is comparatively short, on an average not above ten weeks. The wet includes the remainder of the year. The season's precipitation usually commences with light showers in the middle of September. Above elevations of about 1,600 meters (5,250 feet) these showers are snowstorms in part, but the snow does not remain long. After the first showers there is usually a short interval of dry weather. In the early part of October the rains begin again, increasing in frequency and duration until December is reached, when a storm may last, as it often does, twenty to thirty days, during which time either rain or snow falls incessantly. With the October showers the snow line creeps down rapidly, and in December usually becomes permanent at the lowest levels of the region.

The coldest weather of the season is experienced mostly in the early and middle portions of January, and is pretty sure to be followed soon after by the heaviest snowfall of the winter, considering its duration. This snowfall is often succeeded by a "chinook," a warm southerly wind, which may melt the accumulations of the lowlands wholly or in part. With this the spring commences. This season is often of great length. Rain and snow, freeze and thaw, alternate every few days, very often until the middle of May. There is then a season of dry weather until the middle of June, when a rainy period of two or three weeks sets in. After this has passed dry weather prevails until the fall rains begin.

The precipitation is not equally distributed over the whole region. Certain places receive far more snow and rain than others, even though they are at the same level. The upper portion of the St. Mary and St. Joseph basins and the western areas of the North Fork basin appear to receive more than any other, with the exception of some localities in the main range of the Bitter Roots. I estimate that the places enumerated above, at an altitude of 1,200 meters (or about 4,000 feet), have an annual precipitation of 260 cm. (or about 100 inches) of water. For the remainder of the region it varies between 150 and 220 cm. (59 and 87 inches). The snow at elevations below 700 meters (about 2,300 feet) usually attains a maximum depth not exceeding 1 meter (3.3 feet) for points in the lower portions of the valleys and 1.5 meters (4.9 feet) for points in the central and upper portions. Above this the depth rapidly increases. At 1,500 meters (5,000 feet) it will average 5 to 6 meters (15 to 20 feet), and at 2,100 meters (6,900 feet) perhaps 7 or 8 meters (23 to 26 feet.) This, however, does not represent the true total amount of snow that falls. This is always quite damp and settles very rapidly; besides, there is no frost in the ground throughout the forested portions of the mountains, even at the highest elevations, and the snow melts constantly from beneath.

The amount of precipitation that is given for the various localities cited above is of necessity based upon estimates derived from other sources than actual yearly measurements. There are no complete temperature or precipitation records in existence for any point within the Cœur d'Alene basins. For the present we are obliged, therefore, to estimate from fragmentary observations.

Throughout the areas of maximum precipitation the average number of days during the year on which rain or snow falls is two hundred. For the western areas of the North Fork basin this number is the result of personal observations extending over a period of nearly nine years. For the St. Joseph and St. Mary basins I have no complete observations, but the denseness and size of the forest growth form a pretty accurate criterion by which to judge, and accepting these as a standard, the yearly period of rain and snow in these basins is no less than in that of the North Fork. Over these areas an average fall of rain or snow, reduced to water, is 2.2 cm. (about 1 inch) in twenty-four hours. I have many times measured the fall during twenty-four hours in the months of March, April, June, and October in the North Fork basin and found 4.5 cm. (about 2 inches) a common occurrence. A total fall of 15 cm. (about 6 inches), as a result of a rain storm of three days' duration in March, October, or November, has frequently been noted. In my estimates I have disregarded these measurements to some extent and placed the average daily precipitation during two hundred days at 1.3 cm. (somewhat in excess of one-half inch). We can also form some estimate of the amount of water that falls throughout these mountains by taking the forest growth as a basis. The amount of the yearly precipitation for Spokane has been given as nearly 90 cm. (about 35 inches). Spokane is situated, in a direct line, about 80 kilometers (50 miles) from the extreme western mountain rim of the North Fork basin and about 60 kilometers (37 miles) from the western base of the same. The city is located at the eastern termination of the open plains region of the Columbia River in Washington, and the annual rainfall is barely sufficient to permit a moderate growth of the yellow pine and Douglas spruce there. Proceeding eastward from Spokane in the direction of the North Fork basin, a rapid increase in the density and size of the forest growth soon becomes noticeable. The white fir, the western tamarack, the white pine, and the cedar appear, all of them species requiring plenty of moisture for their development. Finding these trees on the same level and under the same soil conditions as exist at Spokane, we are forced to the conclusion that a greater amount of precipitation takes place where they grow than is the case at the former place, where they are absent. No other explanation for their distribution seems possible. Taking now the annual precipitation for Spokane as a basis, and considering the increase in the forest growth between that point and the one at the western base of the North Fork rim of mountains, an addition of 50 per cent to the annual fall of moisture is very far within the bounds of probability. This would give 135 cm. (about 53 inches) for a point about 20 kilometers (13 miles) east-northeast from Rathdrum, Idaho. The water draining from the adjoining ridges is excluded as a factor in the forest growth, for our station is chosen in a locality where no water flows on the surface and where no subwater is known to exist within 60 meters (about 200 feet) of the same. Proceeding easterly from the station, we encounter the mountain ridges, and the annual precipitation increases at a rapid rate as altitude is gained.

The winds that bring the moisture come from between the south and southwest. For some unexplained reason the exact point between these two directions from which the storms come varies slightly from year to year, but is pretty uniform for each year. It might be named the *dominant precipitation point.* The degree of inclination which this assumes each year in relation to the principal storm lines, the south and southwest, appears to decide the annual amount of precipitation. The nearer to the south the warmer and moister will be the winter; the nearer to a westerly direction the colder and dryer will be the season. But little attention has been given to this feature which I have called the dominant precipitation point, but that it exists is evidenced both by observations of the people living in the region and by certain conditions of the forests, which will be explained farther on. The latter class of records extends over at least two centuries. The circumstance noted here is of very great importance in relation to the conservation of the Cœur d'Alene forests, as we shall see presently. Many of the winter storms appear to come from the north. In reality this is only seemingly so. It is but the lower stratum of air which travels southward in these cases. Whenever we obtain glimpses of the moving cloud masses through the snow or rain during these storms we see that at elevations above 1,800 meters (5,900 feet) or thereabouts they come steadily from a southerly direction, no matter from what quarter the wind blows near the earth's surface. When one of these storms especially distinguished from the more common form by its two strong air currents moving in opposite directions is about to occur, the first indication of its approach is afforded by the cloud formations about the peaks which rise above 1,600 meters (5,250 feet). There are seen heavy masses of grayish-colored clouds rolling from the north along the mountain summits. The lower limits of these clouds are pretty sharply defined. At very high elevations dark clouds are moving slowly from the south. Near the surface of the earth the air is calm. Suddenly the lower stratum of clouds descends to the earth, accompanied by a fierce northerly wind, the upper are much accelerated in their northward course and apparently sink lower, and blinding masses of snow begin to fall.

The northern current in these cases seldom lasts more than two or three days, after which the upper appears to prevail; at least it reaches the lowest levels and blows thenceforth more or less continuously from a southerly direction.

Occasional breaks in the lower cloud masses reveal now and then small clouds forming high up and drifting from the north. This would indicate a reversal of the air currents.

There are no two localities in the Cœur d'Alenes separated by 3 or 4 kilometers (2 or 2.5 miles), or even less, which experience exactly the same climatic conditions though the elevations may in all cases be the same. This statement is not intended to carry with it the implication that the precipitation and the mean annual temperature vary within these narrow limits. The variation consists principally in the unequal distribution of the daily temperature—that is to say, the nights or the days may differ in temperature conditions over such limited areas as here indicated. This circumstance is due to several causes, among which may be noted, first, the general trend of the neighboring ridges, which deflect the air currents in various directions; second, the distance each point is removed from the western rim of the mountains—for, as a rule, the farther east any place in the Cœur d'Alenes is situated the lower appears to be the mean annual temperature. The nightly interchange of air which takes place between the summits of the ridges and the bottom of the valleys or the open plains regions is also a powerful factor in causing local climatic variations. This interchange of air is more marked during the spring, summer, and autumn months than during the winter. When clear nights prevail there is a downward flow of cold air from the crests of the ridges and an upward flow from the valleys. The downward flow follows the canyons and valleys, the upward movement follows the slope. In the inclosed mountain basins it is difficult to estimate the force of this interchange. The downward flow of air is much obstructed by the forest, as is also the upward movement. Fog often forms during the night and is borne along on the downward current. Where no trees obstruct the way the fog clouds are carried at a speed of about 10 kilometers (6 miles) per hour. It is on the surface of the mountain lakes where free traverse exists that we obtain a better conception in regard to the force of these descending air currents. Thus, on Lake Pend Oreille I have observed that the column of air moving out from the valley of the Clark Fork has often at sunrise a speed of fully 35 kilometers (21 miles) per hour. It is blown across the lake a distance of 30 kilometers (18 miles) with undiminished force. It now strikes a rocky, forested shore and is lost to view. The valley of the Clark Fork at the point where it opens out on the lake has a width of between 4.8 and 6.4 kilometers (3 to 4 miles). The front of the moving column of air where it leaves the lake has a width of not less than 24 kilometers (15 miles). We can estimate the width by observing the track of the wind across the lake. The depth of the air column appears to be under 300 meters (1,000 feet), as fog clouds resting upon the mountain slopes at this height are not carried along. The air current which moves out at the opening in the Cœur d'Alene triangle at the point where the Spokane River leaves Lake Cœur d'Alene is much greater in volume and travels at a higher rate of speed. I have felt the effects of this current at a distance of 80 kilometers (50 miles) from its point of emergence. It frequently moves with a velocity of 48 kilometers (30 miles) per hour at a distance of 20 kilometers (12.5 miles) from the above point. These currents of air lower the night temperature over the plains areas that are situated within their sweep and produce many a frosty night during the summer season. Certain conditions are necessary to produce this phenomenon; they are: warm days, clear nights, and a high barometrical pressure.

The deflection of the air currents is a very complicated matter, as might be predicted in a country so rugged and broken. It varies in each separate locality to a greater or less extent, and changes with each year according to the "dominant point" from which the storms come.

There are three principal lines in the Cœur d'Alenes which the deflected currents of air follow to a greater extent than any other, and these storm ways are very well marked by the large quantities of rain and snow that fall throughout their course. They are the valley of the Cœur d'Alene and that of the North Fork of this stream and around the northern apex of the Cœur d'Alene triangle and the upper portion of the St. Mary valley.

In the southern part of the territory the advancing clouds from the southwest first encounter the lower portion of the western rim of the Cœur d'Alene triangle. A portion of the clouds are here driven northward until they reach the gap in the mountains where Lake Cœur d'Alene is situated. They now enter a low region and are afforded a comparatively easy exit toward the east from the pressure behind. Another portion which has passed over the first mountain barrier is massed against the much higher ridges trending north and south which lie to the east of the St. Joseph and which connect with the South Fork ridges at Wiessner Peak. Another deflection toward the Cœur d'Alene River occurs here. Now the ridges to the south of this valley and of its tributary the South Fork are much higher than they are to the northward. The consequence is that a very large proportion of the clouds which have accumulated here are driven northeasterly into the basin of the North Fork. This probably explains why the last-named area receives a larger precipitation than the other parts of the Cœur d'Alene.

The second line of deflection is near the northern part of the Cœur d'Alene triangle. The wind, blowing from the southwest across the plains of the Columbia, strikes with unbroken force the high ridges which form the northern half of the western mountain rim of the Cœur d'Alenes. As before, it is deflected toward the north. Its course is then by the south end of Lake Pend Oreille, over this lake, and eastward by the valley of the Clark Fork of the Columbia. As it approaches the south end of Lake Pend Oreille the rapidly moving column of air, many kilometers wide, is compressed between the Cœur d'Alenes and the mountain range to the west of the lake into a space which has a width of less than 5 kilometers (3½ miles). Passing through this narrow gap, it strikes the lake with terrific force, the wind sometimes reaching a measured velocity of 145 kilometers (90 miles) an hour. In their course up the valley of the Clark Fork the storm clouds deposit most of their burden of snow and rain in the lower portion. The reason for this lies, as in other similar cases, in the configuration of the mountains. The ridges bordering this valley on the north have an average crest line of 1,900 meters (6,200 feet) altitude for a distance of about 130 kilometers (81 miles) east from the lake. This keeps a far larger quantity of clouds confined in the valley than would be the case were these mountains of a lower elevation. Above Thompson the pent-up clouds begin to escape and spread out northeasterly by way of the valley of the Thompson River. Twenty kilometers (12 miles) farther up the Clark Fork valley, at Horse Plains, the northern ridges break away and permit a still further thinning out of the clouds.

We have, therefore, in the portion of the valley of the Clark Fork between Thompson and Lake Pend Oreille, a region of excessive precipitation, locally known as the "Snow Belt." Prior to the forest fires of later years this carried an exceedingly dense forest growth. Above Thompson the climate of the valley becomes one of very decided aridity, resembling in many features that which prevails east of the Rockies in this latitude, and having a flora which includes many of the species of that region.

The third area of deflection is in the upper St. Mary valley. The ridges which form the divides between some of the western tributaries of this stream and those which flow southward into the Clearwater are comparatively low, their mean elevation being about 1,250 meters (4,100 feet).

This permits the escape of a part of the cloud masses which are driven into the Clearwater valley, over into the St. Mary valley. They then follow the course of the valley northward until the northern end of the Elk range of mountains is reached. This range is simply the dividing ridge between the most western of the St. Joseph forks and the St. Mary basin. At the northern end of this range lies a broad plateau which extends from the St. Mary River to the St. Joseph. The air currents pass over this plateau eastward, and reaching the St. Joseph valley are again deflected northward to join the air masses traveling into the valley of the Cœur d'Alene.

The height at which the rain clouds travel varies with the season. The rainy season in the middle of June and the earliest rains in September usually begin from clouds floating considerably higher than 2,100 meters (7,000 feet) above sea level. After the rain has been falling for a few days the clouds go much lower, but seldom under the 1,300-meter (4,300 foot) line. These altitudes are known partly from observations of the height at which the lower or earth surface of the rain clouds travel in their course along and over mountain ridges and crests with known elevations and partly from ascensions of various peaks that have been made while rain and snow storms were in progress, the altitude having been ascertained by means of aneroids.

During the December precipitation the clouds float at their lowest elevation, which seldom falls below 800 meters (2,600 feet). The velocity of the wind during the storm where free and unobstructed traverse exists, as on the summit of the highest elevations, is subject to great variations, but is probably seldom less than 40 kilometers (25 miles) an hour. In the early part of the month of September when I visited the high ridges to the south of Wiessner Peak during the prevalence of one of the early storms of the season, the wind, coming from the southwest, reached at times a velocity of 95 kilometers (59 miles) an hour. This was on the summit of ridges having an elevation of about 2,100 meters (7,000 feet) and unobstructed by trees or higher mountains in the neighborhood. The temperature during the storm, which lasted three days, remained at 9° C. (48.2° F.), and the lower limit of the nimbus was about 1,500 meters (4,800 feet).

The peculiar circumstance was noted in connection with the rain cloud that the side toward the earth was in a continual state of rising and falling. The space through which this took place was about 220 meters (700 feet) in height. The barometer was not affected, but the character of the rain that was falling varied considerably. When I was thoroughly enveloped in the nimbus but little of the contained moisture fell as rain, but from the branches of every tree or upright object the water, condensing from the rain fog, was pouring in streams. Whenever the cloud lifted the rain fell in torrents.

Most of the severe storms begin with electrical disturbances. There are passing showers, accompanied by thunder and lightning which soon cease, and the storm proper begins. Local showers of short duration may occur any time during the dry season and are especially abundant in the North Fork basin. They seem to be mainly a part of the great evaporation which ascends from these moisture-laden ravines during the day, and meeting with a colder current condenses and falls back.

Frosts are liable to occur at any time during the growing season in the bottoms of the valleys within the Cœur d'Alene triangle. Wet summers produce more frosty nights than dry. The reason for this is that the high barometer which follows a storm brings with it a cold, dry condition of the atmosphere. The frosts are most severe at the mouths of the canyons. Elevations of 50 to 100 meters (160 to 350 feet) above the floors of the valleys and the bench lands along the streams are very nearly free from summer frosts and have in general a higher temperature. This patent fact is not generally recognized as yet by the farmers of the region. The valleys would be far more frosty but for the fog which forms above them on clear nights. In the upper St. Mary valley at elevations of 800 meters (2,600 feet), where my opportunities for such observations were of the best, I found that after sundown the temperature would descend steadily until 4° C. (39.2° F.) was reached. It then became stationary and the fog began to form. After 1 a. m. the temperature began to rise, the thermometer indicating 5° to 7° C. (41° to 44.6° F.) at sunrise. Needless to say, the amount of dew which fell was very great.

The highest temperature recorded by me is 36.5° C. (97.7° F.) at Mullan on August 2, elevation 970 meters (3,200 feet). This is an unusually high temperature for this locality. The hot wave was followed by an equally unusual depression of temperature, producing frosts and severe freezing throughout the Cœur d'Alene valleys until August 14. Our lowest record for this period is —3.2° C. (+26.2° F.) at Wolf Lodge on August 14, altitude 750 meters (2,400 feet).

There is no permanent snow line on any of the Cœur d'Alene Mountains. Summers which follow unusually severe winters with heavy snowfall may witness a bank of snow remaining on the north side of some of the ridges throughout the season at elevations above 1,550 meters (5,100 feet). Generally, however, even the highest ridges are free from snow by the 1st of August. Exceptions to this occur on the north side of Stevens Peak, on the northeast slopes of the high rocky ridges some 10 or 12 kilometers (6.2 to 6.3 miles) east from Sunset Peak, and on the northern slopes of the ridges south from Wiessner Peak. In the last locality I found old snow in September with the fresh snow of the season covering it. This is due here, as well as in the other places mentioned, to the great drifts which are blown over the crests of the ridges and accumulate on the northern slope rather than to the elevated position they occupy. When the summer thaw begins great masses of snow are loosened and fall into the chasms below, where the summer's sun can not reach them with sufficient force. This is the case at the foot of the precipices on the northern slopes of Stevens

Peak, where a considerable accumulation of snow, 2 to 3 meters (7 to 10 feet) deep in August, seems to remain permanently.

The highest temperature noted on the high summits was 25.5° C. (77.9° F.) on Stevens Peak, August 5, at an elevation of 2,064 meters (6,800 feet), and the lowest, −2.5° C. (27.3° F.) on July 26, south from Wiessner Peak, at an elevation of 1,925 meters (6,350 feet).

Mention should be made of the chinook wind in connection with these notes upon the climatic conditions of the Cœur d'Alenes. This is a warm, either moist or dry, wind which is supposed to be especially characteristic of winter and spring months. It has decidedly remarkable powers to melt the snow and mitigate the winter's cold. Numerous theories are rife to account for this wind, but the one most commonly accepted is that it stands in some occult relation to the "black current" of Japan. The character of the chinook varies so considerably, however, that one may be pardoned for not readily yielding adherence to this orthodox theory. Now, the way the chinook manifests itself in the Cœur d'Alenes is this: There are clearly two kinds of chinook, a wet and a dry. The wet chinook is a most frequent accompaniment of a very severe snowfall in the latter part of January. This may have commenced with a low temperature, which gradually begins to rise as the storm advances. Finally a cessation of the snowfall occurs. Black heavy-looking clouds appear in solid masses in the southwest, a low soughing sound begins to be heard as the first indications of the coming wind. Soon fitful gusts of warm air flit by, and presently, with loud roarings and crashings and accompanied by torrents of rain, the chinook is on. During a wet chinook a high temperature prevails as far up as the most elevated summits in the Cœur d'Alenes and rain falls in great quantities on the absorbent snow. The duration of the chinook is very uncertain. It may last a week, and it may last only a few hours. After it has blown an indefinite time the wind veers a few points to the west. It then changes to a dry chinook and the temperature becomes much lower. The rainfall in the upper regions becomes snow and freezing weather sets in again in the lower elevations. Chinook winds may occur at any time in the winter, but they are generally absent during December and the greater part of January. Occasionally they do not come until March, and in such cases the region suffers from a late spring. These winds are absolutely essential to the early starting of vegetation in the Cœur d'Alenes, which would otherwise be delayed until the summer season. The chinook is a fitful and uncertain wind in other ways than in its duration. It sometimes blows only above a certain altitude and does not descend below a given point, as, for instance, the 1,000-meter (3,300-foot) level. When this occurs we have the spectacle of the snow melting at elevations above this height while the air is at freezing point in the lowest valleys.

Whatever may be its origin, it does not seem at all probable that the black current of Japan can in any considerable degree exert an influence on the temperature of such a vast amount of air as must be in motion to account for the effects produced by this wind. It is more reasonable to suppose that the real origin of the chinook is in the equatorial regions of the earth, and that in truth it is an outflow of heated air from these regions toward the polar area. In order to pass the high snowy barriers of the Cascades, which it must do to reach us from the southwest, and still to retain a sufficient degree of warmth to exert the marked influence that it does when it reaches the Cœur d'Alenes, it would seem to be absolutely necessary that the initial temperature under which it starts should be very considerable.

The heat carried by the wind is so great that not only does it produce marked effects in the Rocky Mountain region, but it even extends in a lesser degree as far east as the Missouri River in North Dakota.

The supposition that the chinook blows only in the spring and winter is a mistake. My observations record the fact that a wind in every respect identical with the dry chinook prevails throughout the greater portion of the summer months on the summits of the high divides. while it is perfectly calm below.

It is noticed that an odor, frequently said to be "spicy," often accompanies the chinook. A popular fancy ascribes this feature to emanations from the spice gardens of Asia wafted across to the shores of America on the wings of the chinook. These winds certainly have a peculiar odor, but it can not be called spicy. It rather resembles that which comes with the hazy atmosphere of our so-called Indian summers.

MINERAL DEPOSITS.

The economic features of the Cœur d'Alenes group themselves very naturally under three heads: mineral deposits, agricultural capacities, and forest resources.

We will first consider mineral deposits, as at the present time the output of its mines is by far the most valuable product of the country.

The Cœur d'Alenes are essentially a mineral-bearing region, for, with the exception of the portion along the St. Mary and the St. Joseph rivers and the area northeast from Lake Cœur d'Alene covered with basaltic outflows, no considerable portion of these mountains has been found, when prospected, devoid of metalliferous veins.

It is a long time since valuable minerals were first discovered here. At the building of the Mullan road, in 1861, prospectors were found looking for and testing placers in the valley of Wolf Lodge Creek. Before this time some parties must have found their way into the North Fork basin, as very old prospect holes buried in the depth of the forest testify. Hudson Bay Company trappers doubtless found gold in this region at a very early date, but the records, if any, were unwritten, and in the process of time became mere dim recollections. It was not until the fall and winter of 1883 that it became generally known that valuable placers existed on the eastern tributaries of the North Fork. As soon as these discoveries were published a stampede set in, the particulars of which are matters of recent record, and the region began to come into prominence as a producer of valuable minerals. For some time after the gold discoveries but little attention was given to anything else. A year or two later it was found that the great iron-capped veins which traverse various portions of the Cœur d'Alenes carried at certain depths enormous deposits of argentiferous ores. The placers and gold-bearing quartz veins now became of secondary importance. With the discoveries of the lead-silver ores commenced the great development of the mining industries which have made the Cœur d'Alenes known throughout the mining world. The basin of the South Fork is the most noted of all the mineral-bearing zones of this region. Commencing at the town of Wardner, an almost continuous line of large and valuable mining properties extends to within 5 or 6 kilometers (3 or 4 miles) of the main divide of the Bitter Roots. Many of these are great ore producers and are equipped with elaborate and expensive machinery. They give, directly and indirectly, employment to many thousands of persons when in full operation. A number of flourishing towns have sprung up around these mining camps. As these towns depend for their support exclusively upon the mines of the region, their prosperity is naturally inseparably linked with the successful and profitable exploitation of the mineral-bearing deposits which surround them. The low prices of silver and lead which have prevailed for so long, added to the labor troubles of the past two or three years, have very materially retarded the further development of the mining industries of the Cœur d'Alenes. The argentiferous ores of this region are of low grade in the majority of cases and require concentration into proper bulk and richness before they can be shipped to the smelters. As yet there are no smelters in the region. All the big ore producers have large and costly concentrating plants erected in connection with the mines.

The next in importance of the known mineral-bearing districts of the Cœur d'Alenes is the southeastern portion of the North Fork basin. It was here that the gold discoveries were made which first drew attention to the region. In development it has not by far kept pace with the lead-silver areas of the South Fork, notwithstanding the much richer character of its ores. The reason for this lies mainly in the circumstance that the argentiferous ores exist in immense bodies, while the auriferous ores do not; therefore, although the richness of the latter class of ores is much greater, the former have proved more profitable to the miner. The low prices of silver and lead have acted as a stimulus in the development of the auriferous lodes during the past few years, but so far as is now known the gold-bearing region of the Cœur d'Alenes is comparatively limited, and unless discoveries hereafter shall extend it the country will never be noted as a great gold producer.

The two areas enumerated above are the only ones in which any mines have as yet been developed to ore-producing capacities. The total extent of country covered by the mineral-bearing zones here is not one-fifth of the space inclosed within the boundaries of the Cœur d'Alene triangle. That just as great and profitable mines will be discovered in the other four-fifths can scarcely be doubted. The same forces which have acted and the same conditions which exist in the proved mineralized regions appear to have been in operation and to be present in numerous localities elsewhere. In examining the areas where no ore producing mines have been developed to date we find that there is no considerable portion of the country which has been prospected that does not show a greater or less number of recorded mineral-bearing lodes. The basaltic regions of the St. Mary, St. Joseph, and Lake Cœur d'Alene are exceptions to this.

In the upper St. Mary basin we have the placers and gold-bearing veins scattered about Gold Center. In the central portion, on the slopes of the Elk range, a number of mineral locations have been made. In the upper St. Joseph are placers and numerous lode claims.

In the southwestern portion of the North Fork basin is a nearly continuous line of lode claims extending along the valley of the Little North Fork from its junction with the North Fork to its head near Lake Pend Oreille. A great many mineral-bearing quartz veins are known to exist in the northern portion of the North Fork basin, but they are not much prospected, nor are they located under the United States mining laws as yet.

The development work on the majority of mineral-bearing lodes which lie beyond the limits of the two principal mining regions is confined to the annual assessment work of $100 on each claim of 1,500 feet or less, as required by the mining laws of the United States. This means in most instances that a long time must elapse before even the best claims can reasonably be expected to become ore producers. Extensive developments of the mining industries in the Cœur d'Alenes will come in time, but will be matters of slow growth. The miners have many difficulties to contend with, chief of which are low-grade ores, the considerable depth at which the big ore bodies generally lie, the broken character of the country, which in many places renders access by a simple trail to a mining claim troublesome and costly, to say nothing of shipping facilities by rail or wagon roads, and, lastly, the extreme difficulty of inducing capital to invest in mines on areas where the character of the mineral deposits has not been proved to be profitable beyond a reasonable doubt.

As an extended account of the composition and value of the Cœur d'Alene ores would not be germane to the principal topics of this report, only a short general statement is here appended.

There are three main classes of Cœur d'Alene ores—the lead-silver the pyritiferous and free gold, and the dry or cupriferous silver ores. The lead-silver ores are the most common, occur in the largest bodies, and are at the present time the most profitable. Their assay values of silver are very various, running from 20 up to 200 ounces per ton of crude ore. The percentage of lead also varies, though 60 to 70 per cent is a common value. The lead occurs mostly as a sulphide (galena), sometimes as a carbonate at shallow depths. The ores also carry a varying quantity of arsenic, antimony, iron, and zinc in diverse combinations. The lead-silver veins are remarkable for their great length, many having been traced 10 to 20 kilometers (6 to 12 miles), but outcropping ore deposits are only found at long intervals. The balance of the vein is either "blind"—that is, it does not break through the overlying country rock so as to be visible on the surface—or it spreads out and becomes "banded," in which case it is supposed to carry no ore. Veins of this class have in a measure the appearance of true fissures. None has been worked deep enough to be exhausted. They are often very wide where the ore bodies are found and have the appearance sometimes of chambered deposits. Their surface croppings are iron in various stages of decomposition, the so-called "iron cap." The thickness of this varies from 10 to 30 meters (33 to 100 feet) or more, depending upon the amount of surface wear to which it has been subjected.

The auriferous deposits embrace placers and lodes. The placers do not differ essentially from similar mineral deposits in any other region. A great deal of the placer ground of the Cœur d'Alenes remains unworked, by reason of the heavy expense entailed in dealing with the subwater, which is struck before bed-rock or pay dirt is reached.

The auriferous quartz veins are both pyritiferous and free gold bearing. Both kinds of ore are usually found in the same vein. The lodes are narrow and very frequently present the appearance of blanket veins, a feature which is apt to cause some doubt as to their capacity to hold out under long-continued working. There are no very deep excavations on them as yet; hence this point is unsettled. The free gold in these veins will probably turn to sulphurets when a sufficient depth is reached.

The cupriferous silver lodes are not very common. They have been found in the basins of the South Fork, North Fork, and St. Joseph rivers, but have been explored comparatively little. Generally their croppings consist of chalcopyrite or its oxidized or carbonized compounds. The richest ores produced by this class of veins are usually compounds of silver, antimony, and lead in varying proportions.

To sum up the mineral resources of the Cœur d'Alenes, they embrace gold, silver, copper, lead, and antimony, as well as most of the other commercial metallic elements. In the developed districts the four first named occur as great and lasting deposits.

AGRICULTURAL CAPACITY.

The areas fit for agricultural pursuits in this region are very limited in extent. By far the larger portion of the valleys and canyons are narrow and rocky and utterly unsuitable for farming purposes. The best and most extensive acreage of tillable land is found in the lower part of the larger valleys along their slack-water portion. In their upper sections are circumscribed spots of meadow land here and there, but the total amount of this is comparatively small. The narrow lateral ravines which branch off from the larger valleys have practically none, and the hillsides are commonly too steep to utilize for these purposes.

Commencing with the St. Mary valley, we find some agricultural land along the valleys of its western tributaries. The largest and most important of these is the Santianne, which has a length of about 22 kilometers (13.6 miles). The agricultural lands here consist of a strip of meadow on both sides of the stream channel, averaging less than 500 meters (1,640 feet) in width. There are also some timbered bench lands bordering the valley which by clearing can be made tillable. The valleys of the other western tributaries of the St. Mary are similar in character, but have a much smaller area. The largest among these is Emerald Creek. The streams putting into the St. Mary from the east are mere rivulets and have no bottom lands. The lower portion of the St. Mary near its junction with the St. Joseph is bordered for a distance of 5 or 6 kilometers (3.1 to 3.7 miles) along the slack-water portion by a fertile strip of bottom land, which averages about 1.2 kilometers (0.75 mile) in width. Some parts of this are very swampy and springy, and are not utilized. Above the slack water the river runs through a gorge excavated through the basalt for a distance of about 12 kilometers (7.5 miles). No arable land is found here. Above the gorge the valley widens and small patches of low meadow land alternating with rocky bluffs line the stream. Further on, in the upper part, the valley varies from 0.5 to 1.2 kilometers (0.30 to 0.75 mile) in width, and strips of meadow land alternating with willow and poplar swamps make up the character of the bottoms. At elevations varying from 20 to 40 meters (60 to 130 feet) above the river are stretches of bench land, comprising in the aggregate perhaps 12,000 or 15,000 acres. These are pretty generally timbered with a more or less old and dense forest, varying in these respects with the severity of the fires that have swept over them in the past.

At a distance of 51 kilometers (31.7 miles) from its junction with the St. Joseph the St. Mary divides into several forks. Here is found the largest amount of agricultural land occurring in one body above the slack-water portion of the river. There are about 500 acres of it. Practically all the low-lying meadow lands and some of the timbered bench lands in the St. Mary valley below the forks and along its two principal tributaries, the Santianne and Emerald Creek, are occupied by settlers. The settlements on the St. Mary do not extend above the forks. There are no agricultural lands farther up the river.

In the St. Joseph valley the bottom lands, from the outlet into Lake Cœur d'Alene to a distance of 22 kilometers (13.7 miles) up the river, are fertile meadow lands, but in some cases so low as to form perennial swamps. They are embraced within the limits of the Cœur d'Alene Indian Reservation, and are therefore not under settlement. A continuation of these open bottom lands extends to the head of navigation of the stream, and the space is quite generally occupied by settlers. Above the head of navigation are small patches of meadow, alternating with heavily timbered areas and wet cedar swamps, where settlements soon cease. The whole slack-water part of the St. Joseph valley is liable to extensive overflows each spring, occasioned by the filling of Lake Cœur d'Alene and the consequent backing up of the water over its ancient bottom. Part of it is always swampy and too low to be drained and therefore unfit for agriculture. Several small lakes are found in this part of the valley. The overflows from which the valley suffers more or less each year are said to have become a great deal worse since a dam was put in at Post Falls to improve the water power at that place.

Around the shores of Lake Cœur d'Alene is a narrow more or less interrupted series of benches. They are heavily timbered, and would in any case afford but small agricultural areas. For a distance of nearly 25 kilometers (15.5 miles) eastward from the north end of the lake is a rolling country, covered principally with the yellow pine (*Pinus ponderosa*). There are a number of farms scattered over this area, and, with the exception of the Wolf Lodge Creek bottoms and a small space at the outlet of Blue Creek into Lake Cœur d'Alene, the tillable land which they possess has been made by clearing off the forests. The valleys of the main Cœur d'Alene River and that of one of its branches, the South Fork, are the principal centers of population of the region and possess the largest area of agricultural lands. Greater efforts have been made here than elsewhere to transform the forest-covered valleys and benches into arable land.

This is due to the near and ready market afforded by the various mining camps for farm produce and the enhanced value of agricultural lands in consequence. The valley varies in width from 2.1 to 0.5 kilometers (1.3 to 0.3 miles), and settlements and cultivated areas extend throughout its whole length to a point within 10 kilometers (6.2 miles) of the main range of the Bitter Roots at Sohons Pass. The amount of bench lands along this valley is quite limited. The largest quantity of agricultural land in one body is adjacent to the old Cœur d'Alene Mission. There are here about 3,000 acres of good arable bottom lands, nearly clear and unbroken by mountain spurs. but wet and springy in places.

The valley of the North Fork has the least available agricultural land of any portion of the Cœur d'Alene region. The forest is in general so dense that the life of one generation is too short to hew out a farm of sufficient size to furnish support to even a small family. Here, as elsewhere, scattered pieces of meadow land occur and areas where some forest fire of more than ordinary fierceness has in a measure cleared the land.

In such localities small patches of cultivated ground are found at intervals up the valley for a distance of 50 kilometers (31 miles) from its junction with the South Fork. Similar small tracts of tilled land exist along a few of the larger tributaries of the North Fork, such as Beaver, Pritchard, and Eagle creeks, and the lowermost portion of the Little North Fork. Near the head of the North Fork are some meadow lands, but access to them is so difficult that they are not utilized, except in occasional seasons for their crop of wild hay.

The soil of the valleys varies considerably in its composition and fertility, depending upon the constituents of the rocks from which it is derived. In the upper St. Mary region the mountains are largely composed of soft, easily disintegrating, micaceous schists, which have been much worn down. As a result, the outlines of the ridges have been softened and the comparatively large quantities of low bench lands formed which constitute so conspicuous a feature of this area. The basaltic outflows of the Tertiary dammed the stream in its central portion and created a large lake, which extended toward its head. In the still waters of this lake were deposited the wash from the surrounding micaceous mountains, and to it is due the flat character of the upper part of the stream valley and the enormous quantity of finely comminuted silt mixed with vegetable mold which covers so deeply the bed rock of the bottoms.

In the middle portion of the valley the soil has received a very large admixture of alkaline elements, derived from the basaltic rocks which border the stream, and, though not of such depth as in the upper part, possesses a greater fertility. The character of the soil in the main St. Mary valley is repeated in those of its tributary streams.

The slack-water area of both the St. Joseph and the St. Mary have soil of unknown but undoubtedly very great depth, as it represents the accumulation of diluvium deposited over the bottom of Lake Cœur d'Alene during many centuries when it stood at a much higher level than at present.

The soil in the valley of the South Fork along its slack-water portion is similiar to that which exists in the St. Joseph in like situations. There is also a decided element of alkaline deposits due to the leachings from the basaltic rocks around Lake Cœur d'Alene and the St. Joseph.

Above the old Cœur d'Alene Mission the land becomes much less fertile. The mountains adjacent to the valley are composed of highly siliceous rocks, and the soil in consequence is unduly rich in silica. The same conditions prevail in the valleys of the upper St. Joseph and in the whole North Fork basin. In addition, the mold is rather thin, resting upon beds of coarse gravel and sand, the detritus brought down from the main divides by the feeble glacial action which doubtless once operated there. There is also another cause that has aided to impoverish the soil in the upper part of the South Fork, and it is one that operates everywhere in the Cœur d'Alenes under like circumstances. This is fire, which is largely employed to clear the land of its forest covering. There is a stratum, 30 to 75 cm. (12 to 30 inches) in thickness, everywhere in the forest, except in the yellow pine portion, composed of a humus made up of pine needles and woody débris generally in a state of decay. This burns readily, and the ashes which are left as a sort of compensation soon wash off and are lost.

Furthermore, a great quantity of ferruginous matter is held in the soil, possibly in part as sulphides and in part as carbonates. The heat oxidizes this element and the land assumes a fiery red color. Soils which have been oxidized to this extent become exceedingly infertile. The richest lands in the higher parts of these valleys are the beaver flats. Centuries ago the beavers were very numerous here. They dammed the streams in many localities, causing extensive pools. A great amount of alluvial washings accumulated in these places as time passed on. With the disappearance of the beavers their dams were broken down and the places formerly covered by their ponds furnish now some choice agricultural areas, though limited in extent.

On the whole, the land fit for cultivation in the Cœur d'Alenes is circumscribed in area, and the configuration of the country is such that no extensive agricultural operations are possible even were the forests wholly cleared off. Another serious drawback to farming in these mountains is their liability to frosts during the growing season, which are pretty sure to occur with greater or less severity every year. There is no way to mitigate them. The removal of obstructions in the shape of logs, brush heaps, and the like in the streams may create a deeper channel, as it causes a more rapid current, and in consequence a better drainage of the adjacent lands. If this should prevent the formation of the dense fogs which rise on cold nights and serve as a sort of blanket to the earth, it would only result in a greater lowering of the temperature. The removal of the forests also contributes to bring on frosty nights, for it has been abundantly demonstrated that a denuded area in the forests of the Cœur d'Alenes experiences sharper differences and a wider range in the daily temperature than do the places sheltered by the growing timber.

AGRICULTURAL PRODUCTS.

These are the common grains and vegetables. By far the largest quantity of farm produce is hay. In the basin of the St. Mary this is principally timothy. Very little grain is raised here. I saw but a single small field of wheat, and that was raised somewhat as an experiment. There were small garden spots around the farms, on which were planted potatoes and a few of the more hardy vegetables. There were a number of very small orchards; the trees in these were in some instances 8 or 9 years old. They had never fruited, as the frosts during the growing season had invariably killed the blossoms. Small fruits—

strawberries, raspberries, currants, and gooseberries—were seen here and there. The low bench lands had been selected for these gardens and orchards, because their elevation gave them a higher night temperature on an average than the bottom lands possessed. The cultivation of the bench lands in this valley would render possible the production of a far greater variety of farm produce than is practicable upon the land now used. They are, however, for the most part heavily timbered, and when cleared the soil dries and bakes so hard that irrigation becomes imperative, although the annual precipitation is so large. Hay is the principal crop in the St. Joseph valley also. The elevation of the slack-water portion of the valley, 650 to 670 meters (2,100 to 2,200 feet), gives it to some extent immunity from summer frosts. More grain and garden vegetables are raised here than on the St. Mary; also large quantities of small fruits, especially strawberries and raspberries. The production of these is more than sufficient for home consumption, and a ready market is found for the surplus in the South Fork mining districts. Several orchards were seen, none of the trees fruiting very freely, but I was informed that in some years apples, pears, plums, and cherries bear abundantly. Owing to the fact that the slack-water portions of the St. Mary and St. Joseph valleys are elevated above the summer stage of the river only 2 to 3.5 meters (6.6 to 11.5 feet), and that the spring rise of the rivers, or rather the back water of Lake Cœur d'Alene, often amounts to 5 meters (16.4 feet) and upward, they are frequently overflowed for weeks at a time. This entails a severe loss to the owners of timothy fields, as such a prolonged submersion kills this grass. For this reason a large part of the rich meadow lands produces nothing better than coarse sedges and such plants as sweet flag (*Acorus calamus*), tule (*Scirpus lacustris occidentalis*), bur reed (*Sparganium eurycarpum*), water cinquefoil (*Potentilla palustris*), and cat-tail (*Typha latifolia*). The reclamation of these overflowed bottom lands would make them very valuable. It can be accomplished only by lowering the water in Lake Cœur d'Alene. This is possible by widening the channel of the Spokane River at Post Falls, a matter that could be done readily and cheaply. It would, however, destroy in large measure the water power at this point and very materially injure the one at Spokane. The interests that would suffer by a lowering of Lake Cœur d'Alene would be far greater than those that would benefit by the permanent drainage of the overflowed bottom lands of the St. Joseph and the St. Mary.

The neighborhood of Lake Cœur d'Alene insures a comparative freedom from summer frosts to the small quantity of arable land around its shores. Northeast from this lake lies a very undulating region, formed by a multitude of low spurs which in part proceed from the northern half of the western rim of the North Fork triangle and in part from the ridge which forms its base. It is about 25 kilometers (15.5 miles) long by 4.5 kilometers (2.8 miles) wide, is of low elevation, varying from

750 to 950 meters (2,500 to 3,100 feet), and affords a considerable quantity of arable land. This lies sometimes on the long and easy slopes of the spurs, and again on the bench lands which occur here and there. A growth of yellow pine (*Pinus ponderosa*), red fir (*Pseudotsuga taxifolia*), white fir (*Abies concolor*), and tamarack (*Larix occidentalis*) covers this area, which therefore requires clearing before it can be put under cultivation. The summer frosts are not severe over this tract, and in consequence large quantities of garden produce, as well as some fruit—apples, plums, and cherries—are raised.

The slack-water portion of the Cœur d'Alene valley is practically identical with the same part of the St. Joseph valley, though not nearly so extensive. The products are the same, and it is liable to summer frosts and to overflows in the spring, which latter of late years appear to be greater than formerly.

The South Fork of the Cœur d'Alene is closely occupied and cultivated in most of its available portions as far up as the town of Wallace. The timber in the bottom lands is nearly all gone, and the greater part of the land has been utilized for agricultural purposes. The products are hay, potatoes, and garden vegetables. Owing to its configuration, that of a rectangular area opening to the west, it enjoys a rather greater degree of freedom from summer frosts than do the other sections of the Cœur d'Alenes.

As already noted, the agricultural areas in the North Fork basin are very limited. The products are hay and garden vegetables in insufficient quantities to supply even the local demand.

The produce—hay, vegetables, fruit, etc.—of the farming districts of the Cœur d'Alene, the South Fork, and the St. Joseph valleys is mostly consumed at home, the mining camps when in operation furnishing a ready market. This local produce can not be shipped any considerable distance without coming in competition with the products of the plains region of Washington, which can furnish all sorts of farm produce in unlimited quantities and at much lower prices. As, therefore, the home demand will always be the principal outlet for the surplus of the Cœur d'Alene farms, and as this of necessity will be limited for a long time to come, additional farms opened in the timber and among the mountains at great labor and expense will simply add an undue amount of competition to an already fully stocked market.

GRAZING LANDS.

The grazing capacities of the Cœur d'Alenes are small. The forests at low elevations are singularly deficient in species of grasses, and those that occur are very limited in quantity and innutritious in quality. The thick layer of decaying pine needles which is present everywhere in the unburned portions of the timber seems to be inimical to a growth of grass. The dense canopy of interlacing branches that allows but a small amount of heat and light to filter through them and keeps the ground in the heavy forest in a perpetual state of twilight is also among the causes that prevent grasses from obtaining a foothold.

The settlers everywhere keep a few head of stock—horses and cattle. The general range is the forest, and for reasons already stated it is circumscribed in extent and the quality is poor. The areas in the Cœur d'Alenes where stock raising becomes an important factor are the slack-water portions of the Cœur d'Alene, St. Joseph, and St. Mary valleys, the central and upper parts of the St. Mary valley, and the tracts along its tributary, the Santianne.

Except those on the central and upper St. Mary, these lands are bordered by low hills, the ends of the spurs that reach down from the high divides. A great deal of the forest which grows on them is composed of the yellow pine, and is open and park-like in character. There is always a sparse growth of grass in those localities. Much of the low hilly country along the lower St. Mary and St. Joseph is composed of basaltic outflows. The timber here in many places is thin and scattered and a heavier stand of grass is found. The slopes facing the south are more open than those with any other exposure and have more grass land. They are also rockier and with a much thinner soil, generally steeper as well. In the spring and early summer the grass on these slopes furnishes a fair pasturage; in the middle of the summer and later the herbage dries up and stock refuse to eat it unless pressed by extreme hunger. Owing to the limited extent of the range and the absolute necessity of keeping the meadows free from grazing that they may furnish hay for winter feed, each settler can at the best have but a small amount of stock. All the grasses that furnish pasturage on these hillsides and in the forest are easily eaten out, even more so than is the case on the plains areas of Washington and Oregon. The grazing grounds at low elevations are everywhere showing the effects of overpasturage, notwithstanding the number of animals ranging on them is small and they have been utilized but a comparatively short time. During the past ten years thousands of acres of these hillsides, which I once saw covered with a good stand of grass, have been so thoroughly eaten out that now they produce nothing but a few coarse weeds.

The tracts mentioned above are all within the limits of the yellow-pine forest. As we proceed up the valleys we come into regions covered with the white pine (*Pinus monticola*). The pasturage now becomes exceedingly scanty. The range is the forest, as before, but no more open hillsides are to be found. Stock must resort to the densely timbered areas, and the pasturage becomes everything that grows excepting the conifers and the bear grass (*Xerophyllum douglasii*). A common undershrub in these white pine forests, which is often eaten by stock under stress of hunger, is the holly-leaved buck brush (*Pachystima myrsinites*), an evergreen plant belonging to the staff-tree family.

Sharp, broken pieces of the woody portion of this species are often found embedded in the rumen of cattle that have fed in the forest.

The settlers in the Cœur d'Alenes must have access to the forest as a range for their stock, or, except in a few cases, they could not keep any cattle. A quarter section is rarely composed entirely of bottom land except in some portions of the valleys along the slack water. Usually a quantity of forest, some steep ravines, and rocky hillsides form a considerable portion of the farm. The small amount of bottom land must be rigorously preserved for purposes of hay and garden or field products. Sometimes the farm is all forest and there is no natural hay land whatever. When, as is the case in the central and upper St. Mary valley, we find the settlers depending almost wholly upon cattle raising for their support, and observe the small and poor range they have for their stock, and that it is rapidly growing less by over pasturing, the question is forcibly presented, Would it not be to the ultimate advantage of them, as well as to the country at large, if all forest lands were absolutely withdrawn from entry and set apart as timber reserves?

I have not found that the free range of the cattle through the forests is at all detrimental to the conservation of it. They do not eat the conifers, and the deciduous trees and shrubs which are eaten by them in the young stage, or browsed off when they grow older, are of no consequence in any way. Young conifers are, as a matter of course, broken down by their trails, but the damage due to this cause is on the whole insignificant. They prefer to range through the more open portions where saplings and young trees are not so abundant, leaving the denser parts untouched. If agricultural settlements are to be permitted to go on in the timbered regions of the Cœur d'Alenes, there is no reason why the unlimited use of the forest as a stock range should not be permitted, so far as the possible damage done by the cattle is concerned.

There is, however, another aspect to this question which puts the matter of stock raising in a forested region in another light. It has been found that by burning off the timber the grass growth is greatly increased. New species come in, those that were there before grow more robust and acquire a much denser stand, and seeds of various kinds of cultivated grasses will take root and grow if sown at the proper time upon the loose soil which results from the burning process. When a settler lives in the white pine region, or in any other where the timber is heavy, the temptation to burn the forest and make larger and better range for his stock is very great, and it is morally certain many will yield to it. For proof of this it is but necessary to observe the numerous instances in which fires have spread "by accident" from clearings into the adjoining forest. Stock raising and farming in the heavy forest regions of the Cœur d'Alenes is not profitable, and does not furnish a living to those engaged in it. Many have to supplement the income from these sources by the wages they can earn in the harvest fields of eastern Washington or in the mines of the home region.

One would suppose that in a country where natural pasturage areas are so limited and so much in demand all available portions would be utilized. This is far from being the case here, however; outside the slack-water portions of the valleys the best and most extensive grazing grounds of the Cœur d'Alenes are totally neglected. I refer to the great grassy, park-like forests which are found on the high divides that rise above 1,500 meters (5,000 feet) altitude. In the North Fork basin, which has but few natural pastures at any elevation, these parks are of small extent or wholly wanting even on the highest ridges, but on the divides which separate the waters of the North Fork of the Clearwater from the Cœur d'Alene basins, on those which lie between the South Fork of the Cœur d'Alene and the St. Joseph, on those which divide the principal forks of this latter stream, and on the slopes of the peaks near and along the main range of the Bitter Roots are many thousand acres of grass land which yield a most luxuriant growth and are in their prime at a time when the summer pasturage at low elevations is thoroughly dried up. With the exception of small tracts on the Clearwater divide, to which bands of horses are occasionally driven, none of these grazing lands are utilized. The reason for this is in part the difficulty of access to the high summits and in part the lack of water during the summer. To reach the parks on the crests it is necessary to travel through miles of heavy timber or dense brush without roads or trails of any sort. The summer water line is always below these grass lands. Rarely is it found at a higher altitude than 280 meters (900 feet) below the crest line of the ridges; usually it is much lower. The summer water level of the great grass-covered slopes which are situated between the St. Joseph and the Cœur d'Alene rivers varies from 320 to 950 meters (1,000 to 3,100 feet) below the crest line. Above this not a drop of water is obtainable after the snow is gone. Without paths through the dense timber which always succeeds the grassy expanses it often requires several hours to reach water and as long to climb back to the summits. Notwithstanding the drawback of the lack of water, these grassy expanses would furnish good sheep pasture were it not for the presence of bears and cougars, which doubtless would cause havoc in any flock that ventured into these solitudes. The difficulties in the way of utilizing these grazing areas are not insuperable; on the contrary, they can readily be overcome. The only requirements are trails through the timber to the foot of the parks and from them to the highest permanent water levels in the canyons below.

During the past nine years sheep have been driven annually from the Snake River country into some part of the Cœur d'Alenes for summer pasturage. They are driven in by way of Santianne Creek and reach the valley of the St. Mary in the middle of June. Their range is as yet confined to the low, rolling basaltic, yellow-pine forest which lies between the middle portion of the St. Mary and the St. Joseph. As elsewhere, these bands of sheep are very destructive to the pasturage and leave but little along their route for the stock of the resident farmers. In consequence there is a great deal of hostility between the sheepmen and the ranchers. Attempts have been made by the former at various times to drive their flocks up the St. Mary valley, so as to reach the rich pasture grounds on the Clearwater divide, but the threats of the farmers have so far prevented them. The sheep do no more damage to the coniferous trees than do the cattle and horses, and there is no reason, except local hostility, why the sheep herders should not be permitted to utilize the grass lands on the high divides. Small flocks of sheep are owned here and there by the resident farmers. They are not allowed to range through the forest at will, but are pastured in the near vicinity of home. Their number is insignificant.

The cultivated grasses which furnish hay are limited almost exclusively to one species, timothy. Bottom lands high enough to be above the reach of freshets are sown to this kind of grass, but the cleared bench lands are, or rather become, too dry, and they are therefore devoted to wheat or rye.

The small number of the species of grasses found in the Cœur d'Alenes has already been referred to. Not only are the timbered tracts noticeable in this respect, but many of the meadows as well. In the lands adjacent to the slack-water courses of the rivers where the elevation is insufficient to place them above high-water mark there are hundreds of acres in solid bodies upon which not one species of grass is to be found. They are covered with various kinds of sedges, poor and innutritious in quality, but nevertheless commonly cut for hay for want of anything better.

The species of grasses which furnish the bulk of the natural pasturage in the bottom lands are the following:

Graphephorum wolfii, Vasey. A beautiful species in the low meadows throughout the St. Mary basin.

Phleum alpinum L. Found very sparingly along the St. Mary River and extending up into the subalpine heights. (No. 447 from Stevens Peak, altitude 1,650 meters, or 5,400 feet.)

Alopecurus geniculatus L. A grass usually growing in still or running water, but occasionally met with in low places that dry up in the summer and then covering considerable areas with a close matted growth. (No. 1329.) It is called "wild timothy" by the farmers. Cattle do not seem to eat it except when forced by hunger.

Alopecurus occidentalis Scribner. A rare grass in the meadows along the St. Mary River in the central and upper portions.

Agrostis tenuis Vasey. Very plentiful in all the meadows in the central portions of the St. Joseph and St. Mary valleys.

Agrostis scabra Willd. With the preceding, but not so plentiful.

Eatonia obtusata Gray, *Poa serotina* Ehrh., *Deschampsia elongata* Munro, and ***Deschampsia caespitosa*** (L.) Beauv. These four species occur now in the open meadows, now in the forest, and again in the thickets bordering swamps.

Elymus condensatus Presl, and *Elymus glaucus* Buckl. Two grasses almost exclusively confined to the slack-water portions of the valleys.

Festuca rubra L., *Melica spectabilis* Scribner, *Trisetum canescens* Buckl., and ***Stipa viridula*** Trin. Common in the middle and central portions of the St. Joseph and St. Mary valleys.

Danthonia californica Boland., *Poa buckleyana* Nash, *Poa pratensis* L., *Agrostis alba* L., and *Calamagrostis canadensis dubia* Vasey, are species generally disseminated throughout the drier meadows.

Bromus breviaristatus (Hook.) Thurb. A grass which is found accompanying the settlements everywhere throughout the region. It does not seem to be indigenous here; possibly it has been introduced from the plains region of Washington, where it is plentiful. It grows luxuriantly wherever it obtains a foothold, and is esteemed a good pasture grass.

Phalaris arundinacea L., *Beckmannia erucaeformis* Host, *Glyceria fluitans* R. Br., and *Glyceria nervata* Trin. are species which grow in the wet, swampy portions of the meadows and furnish, especially the last, a fair amount of coarse, watery forage.

Agropyron tenerum Vasey. Probably the best of the native grasses of this region. It is not plentiful in any locality.

The species which form the pasturage on the uplands in the yellow pine belt and at low elevations in the white pine forests are as follows:

Calamagrostis suksdorfii Scribner. A grass which springs up in extreme abundance wherever the forest has been burned. It is a coarse species, not much relished by stock.

Poa sp. Common everywhere on the rocky hillsides.

Melica acuminata Boland. and *Festuca scabrella* L. Throughout the open yellow pine forest.

Danthonia intermedia Vasey. In the edge of the forest and on the adjoining meadows.

Agropyron divergens Nees. The most valuable of the uplands grasses at low elevations and furnishing more forage on these areas than any other species. It constitutes the greater portion of the "bunch grass" of the Cœur d'Alenes below altitudes of 1,200 meters (3,900 feet).

The grasses of the parks on the high ridges above 1,500 meters (5,000 feet) elevation are:

Oryzopsis exigua Thurb. A local species not observed elsewhere than on the ridges along the main divide of the Bitter Roots in the North Fork basin.

Deschampsia atropurpurea Hook., *Calamagrostis suksdorfii* Scribner, *Calamagrostis purpurascens* R. Br., *Poa purpurascens* Vasey, *Poa pulchella* Vasey, *Trisetum subspicatum* Beauv., *Agropyron divergens* Nees, *Festuca rubra* L. The last-mentioned species forms at least four-fifths of the total grass growth on the ridges between elevations of 1,500 and 2,100 meters (5,000 to 6,900 feet). It is the "bunch grass" of the high ridges in the Cœur d'Alenes.

Cinna pendula Trin. A plentiful species in the canyons at the altitudes given above. It is an especially characteristic species in wet grounds where the forest has been burned off.

None of the native grasses of the Cœur d'Alenes are worthy of cultivation in that region. No one species is found in sufficient quantities by itself to furnish hay. The wild hay is in consequence composed of a mixture of all the species enumerated above as growing in the meadow lands. The species that grow on the ridges and slopes yield no hay.

Timothy has proved itself thoroughly well adapted to the soil and climate, and wherever the bottom lands are secure from inundation it is generally cultivated.

In some sections that are annually submerged, especially on the areas bordering on the St. Joseph and Cœur d'Alene rivers, sedges become important hay material. The kinds which are most commonly utilized for this purpose are:

Carex utriculata minor Boott, *Carex nudata* W. Boott, *Carex stipata* Muhl., *Carex canescens oregana* Bailey, all of which are very abundant. Others not so common are: *Carex festiva stricta* Bailey, *Carex straminea* Willd., *Carex festiva* Dewey, *Carex pratensis* Drejer.

Carex geyeri Boott. Furnishes more forage in its fresh state than any other of the sedges. It is extremely plentiful everywhere in dry soil. It has an extensive altitudinal range, being found in the yellow pine forest at 650 meters (2,100 feet) altitude and on the summit of the highest ridges at 2,100 meters (6,900 feet). It is of general occurrence throughout the region and is readily eaten by all kinds of stock.

NATIVE FOOD PLANTS.

The native food plants are few. The paucity of plants suitable for human food is one of the most remarkable circumstances in a region which supports such vast quantities of vegetation as does this in its forest covering. Probably, for this reason mainly, it contained only a small aboriginal population, and the only localities in which there appear to have been permanent settlements of the Indians were in the slack-water portion of the Cœur d'Alene—possibly some existed in the lower valley of the St. Joseph. The rest of the country was visited by them only in their migratory summer and fall excursions in pursuit of game and fish, with which the St. Mary and St. Joseph valleys formerly abounded.

The most valuable food plant in the dietary of the Cœur d'Alene Indians was undoubtedly the camass (*Camassia esculenta*), a plant belonging to the lily family, therefore related to the onion, but lacking all trace of alliaceous flavor and smell. The esculent part of the plant is the bulb, which in the fresh state is of an oblong shape, seldom more than 2.5 cm. (1 inch) in diameter and 4 cm. (1⅗ inches) long. It is mucilaginous and possesses very little, if any, definite flavor. The flowers are bright or deep blue, and a camass meadow in full bloom, seen from an elevation, gives the impression that one is looking at a body of very clear water reflecting a cloudless sky. The lower portion of the valley of the St. Joseph, and in particular that of the St. Mary and its tributaries, were, before the advent of settlements, among the classic camass grounds of the Cœur d'Alenes. Here the tribe came in large numbers each summer to dig the root and to hunt the deer and elk, which roamed by the thousand in the surrounding forest, and to catch the trout, with which the streams teemed. Every meadow was a camass field. The plant was so plentiful in many places that it is no exaggeration to say that in the upper St. Mary basin more than one-half of the total herbaceous vegetation in the lowlands was composed of this one species. With the advance of settlements came the utilization of the camass fields as hay meadows. This ended the existence of the plant, except as a weed in the farmers' fields, and the camass digging in the Cœur d'Alene basins, like the game, is now a thing of the past. Strangely enough, the plant seems to have been entirely absent from the North Fork areas, at least I do not know of a single locality where it occurs.

Two species of lichens, *Alectoria fremontii* and *Alectoria ochroleuca*, principally the form *sarmentosa* of the latter species, were eaten by the Cœur d'Alene tribe. Both are extremely plentiful at all elevations. Boiled, or rather baked, in which latter condition they were mainly used, together with venison, they become somewhat gelatinous in their consistency and lose the bitter taste which they possess in a fresh state.

Of fruits, they had huckleberries (*Vaccinium myrtilloides* principally), raspberries (*Rubus leucodermis* and *R. strigosus*), blackberries (*Rubus ursinus* or *vitifolius*), and service berries (*Amelanchier alnifolia*). These fruits are gathered and used at the present time by the white settlers, but none are abundant in the region except the huckleberries and service berries, and these not every year. The Cœur d'Alene Indians draw no more native plant foods from these mountains. They are now mostly farmers, have large and fairly well cultivated ranches, and find in the raising of the cereals and vegetables of civilization a far more bountiful supply of food, and much more palatable withal, than they ever obtained from the laboriously gathered camass of their mountain meadows.

UTILIZATION OF WATER SUPPLY.

Owing to the large annual precipitation, the region is abundantly watered. The lateral ravines which supply the main streams carry water throughout the year with but few exceptions. The annual freshets are usually at their height in the latter part of May or early part of June, and the volume of water then depends upon the winter's snowfall, the amount of rain which has fallen and been absorbed by the snow in the high elevations during the chinook storms of spring, and the suddenness with which the whole mass melts. It is a noticeable fact that more severe freshets are recorded in later years than was the case at an earlier date. In the report of Capt. John Mullan upon the building of the military road it is stated[1] that "the highest water mark seen was only 3 feet above its usual level." This was in 1861 and in the South Fork valley. There are water marks now in the central part of the valley at the old mission which show a rise of over 6 meters (19.6 feet) above the usual level, and in the upper or canyon part of the South Fork, 2.5 meters (8.2 feet). Per contra, the streams are decidedly lower in their fall and winter stage than formerly. The cause lies probably in the removal of the timber. When the builders of the Mullan road first came into the country the forest was in the main intact. The extreme rise in the St. Mary and the North Fork seldom exceeds 2 or 2.5 meters (6.5 to 8.2 feet).

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[1] Capt. John Mullan, Report on the Construction of a Military Road from Fort Walla Walla to Fort Benton, page 121, 1863.

The principal applications of the water in the streams, not considering the item of navigation, are in the mining and lumbering industries, such as furnishing motive power for ore-concentrating plants and sawmills, and means for logging, placer mining, and irrigation. The principal streams whose waters are used by the concentrating plants are the South Fork and Canyon Creek, one of its feeders. Part of the water appropriated by them furnishes motive power; part of it is employed to effect the separation of the metallic part of the ores from the lighter gangue. After it is used the water is of course returned to its channel. It is then heavily charged with the siliceous slimes derived from the crushed gangue of the ore, and more or less of the metallic elements which the concentrating machinery failed to save, such as the sulphides of lead, iron, antimony, zinc, and arsenic in various combinations. The color of the slime-laden water is a dirty gray, and the particles held in suspension are deposited along its course. Undoubtedly some of the metallic elements enter into the water in a state of solution after exposure to the action of moisture and air. After passing through these establishments the water is unfit for either drinking or irrigation purposes. Most of the matter held in suspension is deposited in the calm slack-water portion and little, if any, reaches Lake Cœur d'Alene. So far as I know, no deleterious substance attributable to the concentrators has been detected in the Spokane River. As the water supply of the city of Spokane is taken from this river, the question whether any of the slimes suspended or dissolved pass through Lake Cœur d'Alene into the Spokane is of some importance.

MILLING AND LOGGING.

The water is little, if at all, used as motive power for the sawmills at the present time. Steam is now very generally employed for this purpose.

For logging, the North Fork, Cœur d'Alene, St. Joseph, and Lake Cœur d'Alene are utilized. The stage of water does not permit general driving in the North Fork and upper and middle St. Joseph above the head of navigation except during and for a short time after the annual freshets. The St. Mary would afford water high enough in the spring for this purpose were it not for the obstruction of rocks and its tortuous channel in the canyon where it breaks through the basaltic outflows. This is about 6 or 8 kilometers (3½ to 5 miles) in length. Attempts have been made to pass logs through this canyon, but they have always failed. Logs can be floated down the North Fork for a distance of at least 80 kilometers (50 miles) above its mouth by taking advantage of its highest stage of water. Two of its tributaries, the Little North Fork and another unnamed stream of equal volume, have water deep enough for three or four weeks each year to serve the same purpose. These waterways furnish a means to reach most of the heavily timbered districts of the North Fork areas, as they head near Lake Pend Oreille and drain a large part of the basin.

MINING.

The area devoted to placer mining lies in the southeastern part of the North Fork basin, and it is therefore only here that the waters are utilized for this purpose. Owing to the fact that the channel of this stream lies so much nearer the eastern rim of the basin than the western, it follows that the tributaries putting in from the main range of the Bitter Roots are all short and carry only a small volume of water. Added to this is the circumstance that the bottoms of many are filled above the bed rock to a very considerable depth with masses of gravel and bowlders, which permit the stream of water, small in the fall, to sink beneath the surface. The quantity of water is therefore in many places insufficient for the placer miners in the autumn, and compels them to suspend operations earlier in the season than they otherwise would.

IRRIGATION.

Very little of the water is used for irrigation. The insignificant area of irrigated lands lies almost wholly in the South Fork valley. Water is obtained from the small laterals which are not used for mining purposes and are therefore clear and uncontaminated. So long as the bottom lands furnish most of the agricultural areas, irrigation will be dispensed with whenever possible. When the forest is cleared away from the bench lands and they are put under the plow, the necessity of irrigation will be felt. Lands in the Cœur d'Alenes from which the forest has been cleared become very dry notwithstanding the large annual precipitation. This happens even in case of swampy ground, if it lies above the level of a running stream. The soil does not retain moisture long owing to its largely siliceous nature. The small side ravines will furnish an easy means of irrigating the bench lands so long as the forest at their sources is not cut off. When that is done, the streams will be dry during the growing season, when most needed, and water must then be elevated from the main streams or brought in ditches or flumes from their higher levels.

One problem connected with the water supply of the Cœur d'Alenes may be considered here. It is the possibility of utilizing the streams or the stored-up water in Lake Cœur d'Alene for irrigation purposes on the semiarid lands of the plains of the Columbia. In a general way it may be said that this is feasible to some extent. The physical difficulties, however, are so many and so great and the financial success of an undertaking of this sort so problematical that neither private individuals nor the General Government are likely to engage in any scheme of this kind for a long time to come, if ever.

In the remarks presented in this report upon the configuration of the Cœur d'Alenes it has been seen that the whole area is contained in an inclosed triangle, with an opening that permits the drainage to flow into one of the direct tributaries of the Columbia, and that Lake Cœur d'Alene, into which all the waters of the Cœur d'Alene basins are poured, is situated in this opening or gap. Now, if we desire to take the waters of this region and conduct them upon the plains for irrigation purposes we are limited to two courses. One is to divert the rivers, before they enter into Lake Cœur d'Alene, through artificial channels into the plains areas, the other is to take the water directly from the lake. In either case the ultimate outlet must be through the natural gap in the Cœur d'Alene triangle, for there is no place where an excavation through the inclosing ridges can be made at the proper level.

At the outset we are confronted by the prime difficulty of the undertaking. The surface level of the water in Lake Cœur d'Alene in its medium stage is given by various authorities at 655 meters (2,148 feet) above the sea. Now, the plains region of the Columbia River basin is very far from being a level expanse. On the contrary, it is a very undulating region, with a sort of crest line that stretches from the northwest to the southeast. The course of this is tortuous and lies nearer to the verge of the eastern slope than the western, making that by so much the shorter. Both the eastern and western slopes are intersected by a great number of rocky canyons, the Coulees. The crest line exceeds in many places 910 meters (3,000 feet), and a great deal of the eastern slope will average not less than 720 meters (2,350 feet), excluding the stream valleys. To bring the water of Lake Cœur d'Alene to this plateau at the necessary height to irrigate the uplands, which have most need of it, would necessitate a dam sufficiently high to raise the water level in the lake more than 56 meters (184 feet) above where it stands now. Even then it would not suffice to reach the highest and most arid lands of the plateau. Nor would the difficulties of the work end here. The contour line which joined the raised level of Lake Cœur d'Alene and the plains would be exceedingly tortuous. To conduct the water along this level, miles of rock cutting or high aqueducts would be required.

Another plan is presented, that of taking the water from one of the rivers which empty into Lake Cœur d'Alene. Each of these has a long slack-water portion nearly at lake level. To obtain sufficient head we should be compelled to go far above this portion of the rivers. Omitting all considerations regarding the riparian rights of owners of property below the point from which the water was taken, we will confine ourselves to the physical features. To obtain the elevation of 720 meters (2,362 feet) without a dam would necessitate going up the valley of the South Fork a distance of 20 kilometers (13 miles) above the slack water. The configuration of the country is such that it would be necessary to carry the flume or channel conveying the water along the valley of the South Fork and around the east shore of Lake Cœur d'Alene. This would involve the construction of hundreds of miles of conduits if the contour line was followed. At this point in the river we should have the slimy water delivered from the concentrators, which is wholly unfit for irrigation purposes while charged with siliceous and metallic elements. The waters of the North Fork would not be open to this objection, but the conduits necessary would not be shorter. The same difficulty applies with added force to the St. Joseph, as the length of the necessary water channels would be even greater.

The waters of Lake Cœur d'Alene can be utilized in a limited way for irrigation purposes. It is within a reasonable range of possibilities to dam the lake at Post Falls, and raise its waters sufficiently to irrigate a large portion of the immediate valley of the Spokane River. But a dam high enough to hold back a sufficiency of the surplus water of the spring freshets that the summer stage in the river below would be high enough to maintain the water power at Spokane would submerge permanently all the land which adjoins the slack-water portion of the Cœur d'Alene, St. Joseph, and St. Mary rivers, besides a large quantity abutting upon the shores of Lake Cœur d'Alene. The quantity of land which could be irrigated from this source would be relatively small. Only the lower benches along the Spokane could be reached; the upper are from 30 to 150 meters (98 to 490 feet) above the lake. For the same reason any scheme to take water directly from any of the Cœur d'Alene streams to irrigate the lands of the Spokane valley would not be a financial success.

FOREST RESOURCES.

The Cœur d'Alene basins are or, perhaps more properly, have been a densely forest-covered region. The humidity of the climate and the great depth to which the zone of decomposition of the rocks has extended have combined to favor a surprisingly great development of the forest part of the flora. The growth of timber is by no means uniform throughout the region. Many agencies have operated and are still active to produce present conditions, which will be considered under the head of "Forest destruction."

At the present time the areas which have the heaviest stand of living timber are the central portions of the St. Mary and St. Joseph valleys, the valleys of the various forks of the St. Joseph, and the western region of the North Fork basin. The density of the forest varies with its position as regards elevation and exposure. It is far heavier in the bottom lands and on the mountain sides where the angle of the slopes does not exceed 35° nor the elevation 1,250 meters (4,100 feet) than elsewhere. The northern faces of the ridges have also invariably a thicker stand of trees than any of the others, provided the slope is not too great. The sides fronting the west come next, then those that face the east, lastly the southern exposures, which are very often grassy and have only scattered trees, especially at high altitudes.

Of the two great classes of trees which make up our northern forests on the Pacific Slope the conifers are by far the most abundantly represented in point of individuals. They are also of the greater economic importance. The deciduous trees are the most numerous as to species, but form only an inconsiderable quantity in the forest growth, and their commercial importance is as yet practically none.

There are of the conifers 15 well-defined species. They are distributed among the various genera as follows: pines, 4 or possibly 5; spruces, 1; firs, 2; larches, 1; hemlock spruces, 1; arbor vitæs, 1; hemlocks, 2; yews, 1; junipers, 2. Thirteen among the 15 always attain the stature of trees. One, the yew, is sometimes a tree, sometimes a trailing shrub. Another, the alpine juniper, is always a low, spreading shrub. One, the Western tamarack, is deciduous, shedding the leaves of the season in late autumn, October and November. The others are evergreen.

All the species are of wide range, occurring generally throughout the forests of the Pacific Slope above the northern boundary of California. It is uncertain how many of them range far enough east to enter the Rocky Mountain region proper. I am inclined to think that they all do, with the possible exception of the yew.

The conifers are as follows:

Pines.—Yellow or bull pine (*Pinus ponderosa*), white pine (*Pinus monticola*), black pine (*Pinus murrayana*), white-barked pine (*Pinus albicaulis*).

Spruces.—Engelmann spruce (*Picea engelmanni*).

Firs.—White fir (*Abies concolor*), subalpine fir (*Abies lasiocarpa*).

Larches.—Tamarack or Western larch (*Larix occidentalis*).

Hemlock spruces.—Hemlock spruce, Douglas spruce, Oregon fir, red fir, etc. (*Pseudotsuga taxifolia*).

Arbor vitæs.—Cedar (*Thuja plicata*).

Hemlocks.—Patton hemlock (*Tsuga pattoniana*), Mertens hemlock (*Tsuga mertensiana*).

Yews.—Short-leaved yew (*Taxus brevifolia*).

Junipers.—Red cedar (*Juniperus virginiana*), mountain juniper (*Juniperus nana*).

YELLOW PINE.

Pinus ponderosa Dougl.

The yellow or bull pine stands at the head of the list of the Cœur d'Alene trees as the most generally useful. It furnishes probably not less than four-fifths of all the sawed lumber of the region. It is found in all the larger valleys, in the bottoms and on the bench lands and the slopes of the abutting spurs. The mean elevation of its extreme altitudinal range is 1,250 meters (4,100 feet). In some localities a few trees will be found as high as 1,500 meters (4,900 feet), and in some places it falls far short of its mean range. This is apparently due to difference in precipitation, for the capacity of the yellow pine to endure great atmospheric humidity is decidedly limited. The zone of its greatest density lies between 650 and 850 meters (2,100 and 2,800 feet) elevation. Although of wide distribution, it is far from equally abundant in all localities. In the St. Mary valley it is especially plentiful in the basaltic region, both along the main stream and its tributaries. Above these areas it thins out rapidly, and ceases almost entirely at a distance of about 52 kilometers (32 miles) from the confluence of this river with the St. Joseph. The line of demarkation is quite sharply drawn, and is clearly due to a greater humidity than is compatible with the proper growth of the tree. In the St. Joseph valley the species extends a distance of above 80 kilometers (50 miles) from its outlet into Lake Cœur d'Alene. Around this lake and on the low, broken country which extends from this point to the northeast and southeast until it joins the valley of the Cœur d'Alene the tree is more plentiful than elsewhere. It follows up the valley of the South Fork to the foot of the main divide of the Bitter Roots, but in the upper or canyon part of the valley it is almost wholly confined to the mountain slopes which have a southern exposure.

In the North Fork basin the tree occurs on all the more rocky and open hillsides in the eastern part which face the south. In the large interior and western portions of this area the species is nearly absent. Now and then a few individuals of mature age are seen on some bare, rocky point of a projecting spur, but their numbers are very small and I have never known any of them to produce cones.

The yellow pine in the Cœur d'Alenes varies in height from 30 to 65 meters (98 to 213 feet), ranging in diameter up to 1.5 meters (4.9 feet). The largest diameter which has come under my observation was 2.3 meters (7.5 feet); a fair average is 1 meter (3.3 feet). The species may be considered as mature at 150 years of age. At a certain period in its existence the tree ceases to grow in height. This is marked by the loss of the leader, which begins to fork and branch out in a horizontal manner. Thenceforth it only increases its diameter, and the process is a slow one. In trees 200 years old and upward the annual rings for a distance of 7 cm. (2.5 inches) or more from the periphery will often not average more than 1 mm. ($\frac{1}{25}$ inch) apart. The age at which the species ceases to grow in height varies with the individuals and the conditions under which they are placed as regards soil, humidity, and elevation. I should consider 150 years an average age. The sapwood of the tree is white, almost free from resin, and constitutes from one-third in young trees to one-sixth or one-eighth in old of the total diameter. It is not durable if subjected to alternate wet and dry conditions. In sawing, the larger part of this is slabbed. The heartwood is of a yellowish color, and is always more or less resinous, sometimes exceedingly so. It is very durable, but objectionable and not fit to use for many purposes on account of the quantity of resin with which it is charged. The tree would doubtless furnish a superior article of tar, especially the roots, many of which in dry soils are so highly resiniferous that the woody structure is almost obliterated and they resemble lumps of resin. The tree furnishes a fair fuel and is largely utilized for this purpose. The specific gravity of the wood is only a little less than that of water, but unless the logs are heavily charged with resin they always float. None of the other Cœur d'Alene lumber trees grow in as accessible places as this, and it is therefore a conspicuous mark for the woodman's ax.

WHITE PINE.

Pinus monticola Dougl.

The white pine, as it is commonly called, comes next on the list of the useful pines of the region. It is very much more abundant than the yellow pine, but as it grows in places more difficult of access is not so generally converted into lumber.

When obtainable, the tree is sawed into lumber which is used for all purposes. Owing to its freedom from resin it is suitable in many places where the yellow pine is not. For this reason it is rarely employed as rough lumber. It commands a very much higher price than the lumber from the yellow pine, the difference being as much as three to one, and even more, according to distance. It is often made into shingles which are of a superior quality. The sapwood is white and moderately durable. It varies from one-third to one-fifth (according to age) of the total diameter. The heartwood is white, with a tinge of yellowish brown, and when it seasons it acquires a somewhat satiny feel and luster. Neither the sapwood nor the heartwood is resinous except sometimes a narrow zone of wood around the very core. The green logs are very liable to the attack of a longicorn beetle, which begins to bore holes in the sapwood as soon as the tree is felled, except in winter, and deposits its eggs, which soon hatch out into burrowing larvæ. The tree is also very susceptible to the attack of various fungi, which often destroy every individual over large areas.

The range of the species is universal throughout the Cœur d'Alenes, but it only becomes of a sufficient size to be made into saw logs on areas where there is a plentiful supply of moisture. It will grow on tolerably well-drained slopes, but does not acquire any considerable size. The largest and best bodies of timber of the species are found on the area which lies between the St. Joseph and the St. Mary rivers, from the junction of the two streams to the northern slopes of the Elk Range; along the central portions of the forks of the St. Joseph; in the region which lies directly to the south of the Santianne valley, and in that which is situated between the head waters of the St. Mary and the Potlatch. The greatest, however, is found in the unburned region along the North Fork and in the western and central areas of this basin. The mean extreme altitudinal range of the species is about 1,500 meters (4,900 feet). The zone of greatest density lies between 750 and 1,200 meters (2,500 and 3,900 feet). The height of the approximately mature tree is from 60 to 90 meters (190 to 290 feet), with a diameter of 1 to 2 meters (3.3 to 6.5 feet), which is only rarely exceeded. The average is about 1.2 meters (4.9 feet) for individuals of above height. The crown is about two-thirds the total length of the tree, sometimes not more than one-third or one-fourth, with remarkably short and few branches. The tree is of indefinite growth—at least I have never seen one without a leader, no matter how old, unless it had accidentally become broken. When young the tree is a rapid grower. After 100 to 150 years the annual growth becomes slow. It begins to furnish prime lumber when about 180 years of age. Like the yellow pine, it sets cones in abundance, and there are always a multitude of young trees with the old ones. The fuel from it is of indifferent quality.

BLACK PINE.

Pinus murrayana Balfour.

The black pine is found throughout the whole region of the Cœur d'Alenes. It is unfit for lumber, and is therefore mainly utilized as fuel. It grows tall and slender, and is converted into fence rails, etc., in many localities. There are two varieties of it. One is the prevailing form at low elevations, the other grows mainly at the higher altitudes. The lowlands variety is marked by its dwarfed stature, which seldom exceeds 15 meters (50 feet), low and widely branched crown, and coarsely fissured black bark. This form approaches the black pine of the Washington coast, *Pinus contorta*, of which it may possibly be a variety rather than of *Pinus murrayana*. The typical form of the present species is strictly limited in its range to the mountain slopes and wet meadows in the upper river basins. It has a comparatively narrow crown and a smoothish, brownish bark, and grows from 20 to 40 meters (65 to 130 feet) in height, and up to 50 cm. (1.6 feet) in diameter in favorable situations. Its range extends to elevations of 1,600 meters (5,200 feet). The character of the wood is similar in both forms.

WHITE-BARKED PINE.

Pinus albicaulis Engelm.

This is a species strictly limited both in its altitudinal and regional range, and is but little known or noticed by the people of the Cœur d'Alenes. Within our limits it was more or less abundant on all ridges having a greater elevation than 1,650 meters (5,400 feet), with the exception of the central and western areas of the North Fork basin, where it was not seen. It is especially plentiful on the divide between the Clearwater and the St. Joseph, on the high ridges which separate the latter stream from the Cœur d'Alene River, and along the main range of the Bitter Roots south from Stevens Peak. Its extreme altitudinal range is not known. It is found as large and robust at the highest elevations, 2,160 meters (7,100 feet), as it is at points 500 meters (1,600 feet) lower. The tree attains a height of 20 meters (65 feet) and a diameter of 1.2 meters (4.9 feet), more commonly 40 to 55 cm. (1.3 to 1.8 feet). The crown is very large and spreading, and occupies about two-thirds of the entire height. Very frequently the tree begins to branch immediately at the ground. The crown is rarely symmetrical. The branches are crooked and gnarled and bent in all directions. The wood is white, moderately dense, and resinous. No use is made of the species.

The impression one receives from the general appearance of the tree in this region is that the species is in the process of extinction. Cone-bearing individuals are very rare. Among thousands of trees which I examined for the purpose of obtaining cones I found but a single one, and the remains of old cones at the base of the trees were found but rarely. Few saplings were seen; nearly all the trees were old ones, upward of 100 and 150 years of age.

Possibly climatic changes are going on which are tending toward the obliteration of the tree in the Cœur d'Alenes. These would be less humidity and a general lowering of the mean temperature, in the spring especially, when the young cones are forming. It is a very noticeable fact that the male catkins were present in abundance in the majority of instances, giving the tree the appearance of a diœcious species.

ENGELMANN SPRUCE.

Picea engelmanni (Parry) Engelm.

This is the only representative of the genus *Picea* known to occur in the Cœur d'Alenes. It is of general range throughout, at elevations from 700 to 1,550 meters (2,300 to 5,100 feet); the latter is rarely exceeded. Its principal habitat is in the low, wet bottoms of the streams, which it follows to their source in the ridges. The localities in which it reaches its greatest abundance and its largest development are in the basin of the North Fork. It never forms pure growths, but is always scattered among the other conifers. In favorable localities it grows to a height of 40 to 60 meters (130 to 190 feet), with a diameter of 2 meters (6.6 feet); the sizes one most frequently sees are 0.75 to 1 meter (2.5 to 3.3 feet). In places where other trees do not crowd it, the outlines are exceedingly symmetrical, and with the deep bluish green of the leaves it is by far the most beautiful of the forest trees of the Cœur d'Alenes. In such places the shape of the young individuals, up to the age of 50 years or thereabouts, is a perfect cone from base to summit, the branches commencing immediately at the ground. As the tree grows older the lower limbs die off and the symmetry of the whole is lost in the formation of the thick bole. The crown is seldom less than two-thirds of the height, more frequently as much as three-fourths. The branches are long and pendulous in old trees, but not especially so in the young. It is a rather fast and regular grower and appears to mature at 180 to 200 years of age.

The wood, which is soft, white, free from resin, and quite durable, has a great number of small black knots embedded in it. It is occasionally sawed into lumber, and would be used much more extensively were it easier of access. There is less sap in the tree than in most of the other conifers of the Cœur d'Alene forest, and for this reason it is fit for lumber at an earlier period. No especial distinction exists in color or durability between the sap and heartwood. The species is often confounded with the firs. It may be readily known and distinguished from any of the firs of this region by the thin, scaly, reddish bark of the mature tree, pungently pointed leaves, long, sloping branches, and pendulous cones. Our firs all have upright cones. The hemlocks, which have the mature cones pendulous, differ so much in general appearance that they are not apt to be mistaken for this spruce by anybody.

WHITE FIR.

Abies concolor (Gordon) Parry.

A tree found pretty much everywhere in the Cœur d'Alenes. It ranges from the lowest levels, where it is always associated with the yellow and black pines and the red fir, to elevations of 1,500 meters (5,000 feet), and on the southern slopes of the ridges may go considerably higher. It is equally at home in the wet bottoms of the valleys or on the well-drained slopes of the ridges. On the northern faces of the mountains the young growth frequently forms the densest of thickets, not to be penetrated except by a liberal use of the ax. There are two varieties of the species, but not at all distinct botanically. One of these forms is of low stature, seldom exceeding 15 to 20 meters (50 to 70 feet) in height, and 30 to 35 cm. (12 to 14 inches) in diameter. The branches are long and sloping, and begin from near the base. The wood is soft, spongy, and worthless. It soon decays at the root, and, outside the burned-over areas, furnishes the largest percentage of the woody débris that litters the Cœur d'Alene forests. The other form grows very large. Trees with a height of 60 to 70 meters (190 to 220 feet) and a diameter of 1.4 meters (4.6 feet) are often found. The proper crown is about one-half of the total length of the tree, and the branches are very short and few, diverging at right angles. This form is much less common than the one previously mentioned. It inhabits localities more plentifully supplied with moisture, and ranges to quite as high an elevation as the other. It is sometimes sawed into lumber, and is said to produce a fair article. The smaller form is not utilized for any purpose. It is probable that it would make excellent paper stock. Both forms produce cones rarely and but few at a time. I have never seen more than two cone-bearing individuals of the larger variety.

SUBALPINE FIR.

Abies lasiocarpa (Hook.) Nutt.

A tree of wide range in the Cœur d'Alenes. It is never wholly absent from any portion of the wet valleys of the interior basins and extends up the slopes of the ridges to the highest elevations. As there is no land higher than 2,160 meters (7,080 feet), it can not be determined what the ultimate altitudinal limits of the tree may be in this latitude, but it seems probable that the species would be the last at timber line. In the valleys the tree grows to a height of 20 to 30 meters (66 to 98 feet), with a diameter up to 50 cm. (20 inches), which it rarely exceeds. At elevations of 1,500 meters (4,900 feet) and upward it seldom goes above 18 meters (60 feet) in height and 30 cm. (1 foot) in diameter. On the summit of the loftiest ridges it often occurs very much dwarfed. Trees which do not reach a stature above 2 to 3 meters (6.7 to 9.8 feet) bear cones and show an age of 50 to 60 years. This is more due, however, to a rocky and unproductive soil than to nearness of altitudinal limits. The tree requires an abundance of moisture and at low elevations a northern or eastern exposure. Given this, the lower limit of its range will be the lowest levels of the Cœur d'Alenes, about 650 meters (2,100 feet). In the basaltic areas of the St. Mary and St. Joseph valleys it is frequently found associated with a dense yellow-pine forest. In the valleys the tree never forms a forest of pure growth. It is always scattered among the other conifers. But on the mountain slopes and summits, at 1,500 meters (4,900 feet) elevation and upward, there are often large tracts where the species forms fully 90 per cent of the forest. This is especially the case on the ridges of the North Fork basin. The tree has always a large crown, with rarely a clear trunk, though the branches for a distance of 5 to 6 meters (16 to 20 feet) from the ground may be small and dead. More often they are green quite to the ground. It is of short-lived growth, and the large individuals are mostly rotten in the center. The wood of the tree when it grows in the valleys is very soft and sappy and of no value, even for fuel. On the ridges, owing to slower growth, the wood is denser and contains less sap. If cut and allowed to season, it shrinks and becomes so dense that only with difficulty can a nail be driven into it. It can then be used for various purposes, such as timbering mining tunnels and shafts, and is fully as durable as wood from the yellow pine. The bark of these two species of fir is abundantly supplied with resin vesicles, and they are therefore commonly known as balsam firs. They are frequently confounded with each other, but, aside from other characters, they may be readily separated by the position the vesicles occupy in the bark. On the white fir these are quite superficial and appear as raised blisters, while on the subalpine fir they are sunken, and rarely appear elevated above the surface of the bark.

TAMARACK.

Larix occidentalis Nutt.

The only species of deciduous conifer in the Cœur d'Alenes. It is plentiful everywhere—in the canyons, on the mountain slopes and summits, and even among portions of the low-lying yellow-pine forest. It is a noble tree when seen in its favorite haunts, which are the wet, gloomy canyons of the interior basins, where it often vies in size with the white pine. It grows here to a height of 30 to 60 meters (100 to 200 feet), frequently with a diameter of 2.4 meters (8 feet). The crown is composed of short, straight branches, and is about three-fifths the total height of the mature tree. The individuals that are found on lower levels, especially in the yellow-pine forest, have a much larger crown; often five-sixths of the entire length of the tree is composed of this, and the branches are long, slender, and slope downward at a high angle. Its altitudinal range is between 650 and 1,900 meters (2,100 to 6,200 feet), reaching its greatest size between 850 and 1,000 meters (2,800 and 3,300 feet). In its youth it is a rapid grower. During the first 30 to 40 years the spaces between the annual rings will average 5 mm. ($\frac{1}{5}$ inch) in favorable localities. As it advances in age the annual increase in its diameter becomes very much less, until at 180 to 200 years and upward there is often not more than 0.5 mm. ($\frac{1}{50}$ inch) between the yearly layers. The sapwood is white and forms but a narrow zone a few centimeters wide. The heartwood is of a yellowish or reddish tint, and is very heavy, full of sap, and frequently seamed with long, wide gum cracks. The specific gravity of the wood is slightly higher than that of the yellow pine, and the logs often sink when put in water. To obviate this the butt end is sawed off a few meters above the cut, or holes are drilled in the logs and tightly plugged. It is largely sawed into lumber, which, however, is apt to wear very rough unless care is taken in sawing. It makes excellent fuel and is one of the two trees in this region which supply most of the cross-ties used by the railroads. The fiber is short and the tensile strength low; it is therefore, so far as I know, never sawed into square timber for bridges, beams, etc.

HEMLOCK SPRUCE.

Pseudotsuga taxifolia (Poir.) Britton.

The hemlock spruce is, next to the yellow pine, the most generally useful of the Cœur d'Alene conifers. Both its regional and altitudinal range are very much greater than those of the yellow pine. It is found in all portions of the Cœur d'Alenes, from the lowest level to elevations of 2,160 meters (7,100 feet). It is equally at home in the humid valleys or on the well-drained mountain slopes. In the lowlands it reaches a height of 50 to 70 meters (160 to 230 feet), with a diameter which seldom exceeds 1.3 meters (4.2 feet); on the dry hillsides it is of slow growth, and the crown constitutes about two-thirds of the total length of the tree. In the valleys it grows more rapidly and the boles form long, straight, cylindrical columns. In such cases the crown may occupy less than one-fourth of the total length of the tree and is made up of short, straight branches. The sapwood is white and varies from the one-tenth to the one-sixth of the diameter, according to age. The heartwood is sometimes yellow and sometimes pink or reddish. The yellow variety is soft, easily worked, and much preferred; the red is very tough, considerably harder, and less esteemed for general purposes. The wood contains but little sap, and is therefore comparatively light. It is sawed into lumber for all purposes, and owing to the small quantities of sap will furnish a fair quality at an earlier age than the other conifers of the region. It is much cut for railroad cross-ties, and, together with the tamarack, furnishes fully 85 per cent of all this sort of timber drawn from the Cœur d'Alenes.

CEDAR.

Thuja plicata Don.

A beautiful and valuable tree occurring plentifully in many localities throughout the Cœur d'Alenes. It is popularly designated as cedar, but a more proper name is arbor vitæ. It is not equally distributed, but thrives best in low, swampy localities, at the outlet of streams, around and on the former sites of beaver ponds, and in the neighborhood of wet, springy places generally. At the same time it is not entirely absent from the dry mountain slopes. The areas upon which it is found most abundantly and of greatest size are the central portions of the St. Joseph and St. Mary valleys and along the North Fork for a distance of 80 or 90 kilometers (50 to 55 miles) above its junction with the South Fork. There are also many localities of minor extent scattered here and there throughout the inaccessible parts of the upper tributaries of the streams, where it is found in small groves and occasionally of large size. In the upper part of the valley of the South Fork the tree formerly existed in large numbers and of gigantic size, as is attested by the old stumps one sees everywhere in that locality, but it is now nearly destroyed by forest fires and the ax. It is absent from over the major portion of the western half of the North Fork basin, an inexplicable circumstance when it is considered that the climatic conditions and the elevations are not essentially different from those that prevail over other areas where the species is plentiful.

The tendency of the tree is to form groves of pure growth. The interlacing branches, cutting off the sunlight from the ground beneath them, produce a condition inimical to the growth of other kinds of conifers. Owing to its habitat in places where the soil is continually saturated with water and to the exceedingly firm hold the roots have on the earth, it often stands a fair chance of escaping the forest fires and of successfully resisting the fierce gusts of wind that sweep the canyons occasionally and uproot thousands of trees of other species. We therefore find among the groves individuals which far surpass in age and diameter any of the other trees of the region. Specimens have been seen 4 meters (13.5 feet) in diameter. If the growth of such an individual was approximately in the same ratio as is that of trees 1 to 1.5 meters (3.2 to 4.9 feet) in diameter, it would have been not less than 1,200 years of age. Probably it was far older, for with advancing age comes slowness of growth.

The altitudinal range of the species is between 650 and 1,500 meters (2,100 to 4,900 feet). The tree grows from 20 to 50 meters (65 to 164 feet) in height, with a diameter which varies from 1.5 to 2.5 meters (4.9 to 8.3 feet). The length of crown is commonly three-fourths of the total length of the tree, but is subject to considerable variation in this respect. Where it grows in very close and pure groves it may not be above one-half the whole length.

The bark of the tree is tough and stringy, and is used by the Indian tribes of the Northwest in making mats, baskets, etc. The sapwood is white, and forms a mere narrow zone 1 to 3 cm. (0.4 to 1.2 inches) broad. The heartwood is reddish, pleasantly odorous, light, entirely free from resin, and does not contain much sap. In large trees it is more or less rotten, and sometimes the whole trunk of the tree is only a thin shell, the balance having decayed.

Probably not less than 80 per cent of the trees 1 meter (3.3 feet) and upward in diameter are rotten at the core. As the center of the tree is not much used in any case, a moderate quantity of rot does not materially lessen its value. The grain of the wood is rather coarse, it splits easily, and is brittle. It is a moderately rapid grower, and is more uniform in this respect than any other of the Cœur d'Alene conifers. The principal use of the tree is in the manufacture of shingles. It is also occasionally sawed into lumber for inside finishings. This is said to take a fine polish and to acquire a deeper color with age. As the wood is very durable when in contact with the soil, it is largely employed for fence posts, telegraph poles, bridge piles, and the like. It makes very inferior fuel, and is rarely used as such in the region where it grows. Owing to the knotty character of the wood, the waste of material in shingle making is enormous. The shingles are sawed out of the wood between the knots and the balance thrown away. When a shingle mill is located near a stream its presence is always made known by the great quantities of knotty rejected shingle bolts and blocks that litter the banks of the stream.

Owing to the rapid growth of the tree, it is early fit for various uses. At 20 to 50 years it will furnish rails, fence posts, and telegraph poles. At 150 to 350 years the tree is in prime condition for shingle bolts and and lumber. Above this age the rot at the core is apt to extend so far toward the periphery that the value of the tree is small.

PATTON'S HEMLOCK,

Tsuga pattoniana (Jeff.) Engelm.

This species of conifer is comparatively unknown to the majority of the people of the Cœur d'Alenes, and when seen is frequently confounded with Mertens's hemlock (*Tsuga mertensiana*). It is a tree which in the Cœur d'Alenes is pretty closely confined to the higher divides. Its range is from the Clearwater divide in the south, where it forms more than 75 per cent of the forest, through the canyons and on the divides of the upper St. Joseph, on all the divides between the St. Joseph and the Cœur d'Alene River, throughout the main range of the Bitter Roots, on the divides between the North and South forks east of Nine-mile Creek, and sparingly on the higher peaks in the eastern part of the North Fork basin. It is absent from all the ridges, except the Clearwater divide, which form the basin of the St. Mary River, from all the mountains around Lake Cœur d'Alene, and from the whole western portion of the North Fork basin. The tree is essentially an inhabitant of the high ridges above an elevation of 1,500 meters (4,900 feet). It forms here a very large proportion of the forest growth. It is much more abundant on the Clearwater divide and on the upper St. Joseph than elsewhere, diminishing very rapidly in numbers as we go northward.

The species is well adapted to stand the severe winter blasts of these high, exposed ridges. Large trees are seen only in protected saddles or sheltered ravines; on the open part of the mountains, where the tree stands alone or in scattered groves, the species is low and squatty and the branches are short and stiff, to retain as little snow as possible and to present a small surface to the storms. It is of slow growth. A tree 15 cm. (6 inches) in diameter showed 75 annual rings. This was in an exposed rocky place, where the growth was perhaps slower than in more favorable localities. In sheltered places, in the saddles of the ridges, and in the upper portions of the canyons which head in the Clearwater divide the tree is seen to best advantage. It reaches here a height of 30 to 40 meters (100 to 130 feet), with an extreme diameter of 70 cm. (28 inches), commonly from 35 to 50 cm. (14 to 19 inches). The crown on such well-developed individuals is about three-fifths the total length of the tree. Its growth is slow, even with the most favorable surroundings. Trees with a diameter of 50 cm. (19 inches) will give 200 to 250 annual rings. The wood is very dense, close grained, and hard, utterly unlike the wood of any other conifer of the Cœur d'Alenes. It resembles, in a degree, as to its qualities, the wood of the white ash of the eastern United States. If the species grew in accessible places it would be a valuable tree and be extensively used. As it is, the tree is not utilized in any way. The bark contains but little tannin. It is one of the few species inhabiting the high ridges of the Cœur d'Alenes which bear cones abundantly each year. This and the white-barked pine (*Pinus albicaulis*) are the only trees in these mountains which have a strictly limited lower range.

MERTENS'S HEMLOCK.

Tsuga mertensiana (Bong.) Carr.

A common species and with a regional distribution practically throughout the Cœur d'Alenes. The area upon which it grows most plentifully and attains its largest development is the western portion of the North Fork basin. About 30 per cent of the forest is here composed of this one species.

Unlike Patton's hemlock, it is a tree which belongs to the low, wet valleys, and is rarely seen above 1,400 meters (4,600 feet) elevation. It is of extremely slow growth in most localities. Trees 12 to 15 cm. (4.7 to 6 inches) in diameter, which will count 120 annual rings, are very common. This slow growth is especially marked where the trees are set close. When a larger space intervenes, the trees grow faster and attain greater size. An average height, rarely exceeded, is 40 to 55 meters (130 to 180 feet), with diameters up to 70 cm. (28 inches), but sometimes groves are found which contain individuals with a diameter of 1.8 meters (5.9 feet). It is usually a very branching tree, with excessively long laterals. The crown is about two-thirds the total length. As the tree is often plentiful in accessible localities, it is frequently sawed into lumber. This is of fair quality, and when seasoned it becomes dense and hard, so that a nail can be driven into it only with difficulty. The bark appears to carry a considerable quantity of tannin, and the tree could probably be used as a source of tan bark.

YEW.

Taxus brevifolia Nutt.

This species of tree, while classed among the cone bearers, does not produce a cone as its fruit. In the month of August there will be seen in the forests where the species grows a tree, or long, straggling shrub, with evergreen leaves in appearance like those of a fir, and bearing bright red berries. This is the yew. The tree ranges throughout the Cœur d'Alenes, with an extreme altitudinal limit of at least 1,600 meters (5,300 feet). It is nowhere abundant; perhaps more nearly so in the North Fork basin than elsewhere. It rarely attains the stature of a tree; more commonly it is a shrub, with long, irregular branches, which sometimes reach a length of 10 meters (33 feet). Near Lake Pend Oreille and in the upper part of the North Fork basin I have seen trees having a height of 20 meters (66 feet) and a diameter of 35 cm. (14 inches). Such trees exhibit the characteristics of the species more fully than the shrubby forms. From a specimen of this sort I draw the following description: Height, 20 meters (66 feet); diameter, 35 cm. (14 inches); branches beginning 3 meters (10 feet) above the base; crown very wide, with a great number of long laterals drooping at an angle of about 45°; bark reddish, close, thin, of a leathery consistency; wood reddish, hard, fine grained, full of knots, but very readily fissile between them, apparently capable of taking a bright polish; wood of the trunk breaking with a short fracture, that of the limbs very flexible; sapwood, 1 cm. (0.4 inch) thick, white; heartwood, 34 cm. (13.4 inches); annual rings, 185. In this region the tree is too rare, small, and knotty to be of any commercial value.

RED CEDAR.

Juniperus virginiana Linn.

A low tree rarely exceeding 6 meters in height (20 feet) and 20 cm. (8 inches) in diameter. Its habitat is on rocky banks, principally around lakes Cœur d'Alene and Pend Oreille. Its altitudinal range lies below 700 meters (2,300 feet). The wood is fragrant and reddish in color, hence the popular name "red cedar." The tree is too small and scarce to be of any commercial value. Mountain juniper (*Juniperus nana* Willd.) is a mere shrub, prostrate or trailing over the rocks at elevations of 1,800 meters (5,900 feet) and upward; of no value.

A summary of the conifers as to their principal economic uses will stand as follows:

Lumber.—Yellow pine, white pine, Engelmann spruce, tamarack, hemlock spruce, cedar, Mertens's hemlock.

Shingles.—White pine, cedar.

Railroad cross-ties.—Tamarack, hemlock spruce.

Telegraph poles.—Cedar.

Fence posts and rails, fuel.—Any and all of the species.

The deciduous trees of the Cœur d'Alenes are as follows:

Cottonwood, balm of Gilead (*Populus angustifolia*).
Aspen (*Populus tremuloides*).
Birch (*Betula occidentalis*, *Betula papyrifera*).
Mountain maple (*Acer glabrum*).
Alder (*Alnus rhombifolia*, *Alnus viridis*, *Alnus tenuifolia*).
Willow (*Salix lasiandra*).
Cherry (*Prunus demissa*, *Prunus emarginata*).
Chittim wood (*Rhamnus purshiana*).
Thorn (*Crataegus douglasii*, *Crataegus tomentosa*).
Service berry (*Amelanchier alnifolia*).
Mountain-ash (*Sorbus sambucifolia*, *Sorbus occidentalis*).

With three exceptions, all these species occur throughout every portion of the Cœur d'Alenes. Those of local distribution are: *Alnus rhombifolia*, *Cratægus tomentosa*, and *Sorbus occidentalis*. Such of them as reach high elevations often become mere shrubs. None are of any economic importance. It has been stated that the wood of the poplar works up well into a fair article of paper stock, and that it can not be excelled for purposes of match making. None of the native trees are transplanted or cultivated.

FOREST ZONES.

To obtain an accurate conception of the Cœur d'Alene forests as we find them now, and to enable us to treat the subject comprehensively, it is necessary that a division into *zones* or districts be made. There are various advantages in such a partition. It will enable us to treat each part specifically, and when we come to consider the problems connected with the destruction and preservation of the growing timber we can the more readily refer to any of the various sections comprising the same. I propose to make two classifications of the coniferous forests of the Cœur d'Alenes, basing them upon (1) the vertical range of the species; (2) upon the age of the trees which predominate over any given area. The former of these is the plan generally used in mountainous regions to define the presence or absence of species within certain limits. The latter has, so far as I am aware, never been employed in the West to characterize the condition of the general forest growths over large areas. It is, however, by far the best and most reliable from an economic point of view, and, as it is applicable to all our Western timber regions alike, should be employed in all cases where an accurate knowledge of the condition of the forest is desired. Both classifications will apply to any of the forests of the Pacific Slope. But there is this to be observed, that the limitations of the former will always vary with the species which compose the forests and the latitude of the region where they grow, while the latter can be applied alike to all areas, no matter where situated. For this reason, if we wish to know the actual state of the forest growth of any region of the West on a basis of these divisions, we must have a table of the vertical limitations of the forest zones of such locality. Given this, with the data of age demanded by the second division, we should be able to form a very accurate conception of the true condition of the forest anywhere.

According to the first principle of classification, namely, the species of conifer which is most abundant or characteristic in each section, the forests may be divided into four parts. They will be designated thus: The Lower, or Zone of Yellow Pine (*Pinus ponderosa*); the Intermediate, or Zone of White Pine (*Pinus monticola*); the Upper, or Zone of Subalpine Fir (*Abies lasiocarpa*); and the Crest Line, or Zone of White-barked Pine (*Pinus albicaulis*).

The second classification will give us four categories: Old Growth, Second Growth, Young Growth, and Recent Burns.

It must not be understood that these sections are absolute in their limitations. Innumerable variations and modifications are found to occur when each is taken up specifically. But in general they will stand, and are infinitely preferable to the customary "lumping" of the forest region into one very heterogeneous mass.

In attempting to limit the vertical extension of the coniferous forest zones of the Cœur d'Alenes we meet at once with a serious difficulty.

This arises from the fact that the lower boundaries of most of the species are ill defined. We shall find that the cause of this is the infinite variety of climatic conditions, which is such a marked feature of the western extensions of the Bitter Root Range.

The tortuous courses of the mountain ridges and the canyons are the main causes of the innumerable local variations of climate. The mean annual temperature of any given portion of a ridge or canyon varies with its direction of exposure, and this does not simply refer to the cardinal points of the compass. Almost every degree of inclination to any of these directions involves a corresponding change in the prevailing temperature conditions. This occasions differences in the precipitation, and, though we have no data by which we can demonstrate the difference between a south and a north slope, yet it is a fact well established by observation that more rain and snow fall on the latter than on the former.

It must here be taken into consideration that the evaporation from the southern slopes is greater than from the northern, and that the visible effects upon the vegetation, from the same amount of rain and snow, would therefore be less on the meridional sections of the ridges than on any of the others. It is not temperature conditions alone which influence the precipitation. There is another very potent factor to be found—the mechanical impact of the wind. Let anyone who doubts this go to the summit of some of the high ridges, say from 1,500 to 2,100 meters (5,000 to 7,000 feet) altitude, and remain there during a rain or snow storm. It will be seen then that a large quantity of the air which is driven against the southern face is deflected upward with great force and velocity, carrying with it enormous quantities of clouds, which sink and are thickly massed as soon as the calmer and cooler north or lee side is reached. The rending asunder of the cloud masses by this upward current diminishes the amount of moisture precipitated from them. Part of the deflected air and clouds will, if the ridge is high enough, pass through the low gaps or saddles in the mountain. The heavier growth of timber in these saddles than elsewhere in the neighborhood is due to this rather than to the drainage from the higher parts of the ridges, which would not flow toward the depression unless the dip of the strata favored it. The phenomenon which I have designated the dominant precipitation point plays a part here; but however much this may vary from year to year the condition of the forest as a whole proves that there is a general mean in it, and that the variation is not sufficient to exert a permanent influence in the distribution of the species.

From a consideration of these climatic conditions we shall not be surprised to observe the poorly defined vertical limits of the Cœur d'Alene conifers, and as great humidity is the predominant climatic feature of the region, we may expect the species of the elevated portions, which can endure these very conditions, to descend to low levels. On the contrary, the trees of the lowlands thriving only in drier air and soil would not extend far upward, and, in point of fact, we find that the upper limits of the coniferous zones are far better defined than the lower.

The Cœur d'Alenes possess no proper foothill region, unless the small area to the east of the north end of Lake Cœur d'Alene can be so called. If there were a central ridge whose slopes were continuous with a lower or plains region, the diversity of climatic conditions now experienced would not be met with inside the Cœur d'Alene triangle, and the forest zones would be far more readily defined.

I will now pass to the question of the limits of the forest zones and the features which give the distinguishing character to each.

ZONE OF YELLOW PINE.

There is first the Lower, or Zone of Yellow Pine. This is at the present time by far the most important from a lumberman's point of view, as, owing to its accessibility, it supplies the larger portion of the logs sawed into lumber. The principal upper and lower limits of its vertical range are between 650 and 850 meters (2,100 and 2,800 feet). It is marked by its open character. The trees stand far apart and there is but a sparse undergrowth, generally made up of species of *Opulaster* and *Rosa*, *Holodiscus discolor*, *Ceanothus sanguineus*, and an occasional *Philadelphus lewisii*. The ground is covered with a fair, sometimes a very luxuriant, growth of grass, principally species of *Festuca* and *Poa*, with occasionally an area of sedge—*Carex geyeri*. There is not much fallen timber. Where the growth is pure the forest is park-like and has a clean and open appearance.

Usually, however, the growth is mixed, and here and there among the yellow pines are more or less extensive groves of Douglas spruce, white fir, and the lowlands form of the black pine. In low or moist places will be found the tamarack. The Douglas spruce sometimes replaces the yellow pine to the extent of 75 to 80 per cent, and the black pine occasionally crowds it out altogether. In such cases the forest growth is dense. A heavy stand of these species is a sort of transition ground to the next section. The undergrowth will be the same as that of the typical yellow-pine forest, but in addition there will be a multitude of young trees of the white fir, so crowded that the larger number will never develop beyond mere shrubs.

The number of trees to the acre varies so greatly that it is almost impossible to give, even approximately, an accurate estimate. I should consider that in a yellow-pine forest untouched by the ax, 20 to 30 trees of *Pinus ponderosa* or of *Pseudotsuga*, 70 cm. (28 inches) and upward in diameter, would be a fair average. Where the timber is mixed the diameters of the trees will average much less and the number is greatly increased. Thus in a black-pine grove an estimate of 1,000 to 1,200 to the acre, 15 cm. (6 inches) and upward in diameter, would not be at all excessive. The limits of the Zone of the Yellow Pine are influenced as much or more by the amount of the annual precipitation as by altitude. The ponderosa pine will not endure excessive humidity; therefore the area covered by this section is the one upon which less snow and rain falls than any other in the Cœur d'Alenes.

ZONE OF WHITE PINE.

The next section is that of the White Pine. In this zone occur the heaviest and densest forests of the Cœur d'Alenes. Its vertical range lies between 900 meters (3,000 feet) for the lower and 1,400 meters (4,600 feet) for the upper limit. As the mean of the extreme altitudinal limit of the yellow pine as a tree is about 1,200 meters (4,000 feet), we find more or less of an overlapping of the White Pine Zone by that of the yellow pine. The areas on which the White Pine Zone reaches its best development are all the wet stream valleys and the mountain slopes with a northern exposure. While as a whole the predominating species in this section is the white pine, we seldom find it forming pure growths. Accompanying it are the majority of the conifers of the Cœur d'Alenes, and some species find here their greatest development. These are the cedar, Engelmann's spruce, Douglas spruce, white fir, and Mertens's hemlock, Western larch in the lower parts of the zone, and the mountain form of the black pine in its upper.

The distinguishing feature of this zone in its vegetative aspect is the denseness of its growth and the great height of many of the trees. The stand of forest is very close; there is a vast amount of vegetable débris, decaying trees, fresh and old windfalls piled upon one another, broken-off tree tops, and young trees bent over by the snow and forming impenetrable thickets. Very little grass, more often none at all, grows on the ground, which is heavily covered with a humus reeking with moisture and topped off with a growth of mosses and liverworts. Multitudes of fungi are everywhere, representing numerous species and genera. In the fall of the year the ground is fairly carpeted with them.

Densely tangled masses of underbrush abound. The shrubs that form these are commonly various species of willows and alder, thorn, mountain maple, red cornel, the holly-leaved buck brush (*Pachystima myrsinites*), and species of elder.

The number of trees per acre is always considerable, but varies widely. A fair estimate per acre for the bottoms of the canyons would be 600 to 700 trees, with diameters from 25 cm. to 60 cm. (10 to 24 inches), and 2,000 to 3,000 trees, with diameters from 15 cm. to 25 cm. (6 to 10 inches); of saplings there are often tens of thousands on the same space in addition to the larger growth.

ZONE OF SUBALPINE FIR.

The third section is that of the Subalpine Fir. Its vertical range lies between 1,500 meters (4,900 feet) for the lower limit to 1,700 meters (5,600 feet) for the upper. The boundaries of this zone are intended to include the area upon which the subalpine fir forms more or less extended forests of nearly pure growth. The altitudinal limits of the species are very much greater. This zone is always upon the high slopes and summits of the ridges where an abundance of snow falls and the drainage is good. It is marked by its open character. The undergrowth of shrubs is mostly confined to the saddles and northern slopes, and consists of huckleberry shrubs, mountain ash, alder, and menziesia. The trees stand widely apart, and when there is no undergrowth the ground is heavily carpeted by the bear grass. The appearance of the forest then is that of a park. Occasionally the undergrowth, especially in the saddles, is entirely made up of saplings of this fir. In such cases the young trees stand so close that it is impossible for a man, even on foot, to make his way through them without a liberal use of the ax. There is but little fallen timber in this zone. The trees are short and firmly rooted and do not topple over easily. Various species, whose range is mostly at lower elevations, extend into this section, but seldom grow to large size. Such are the Douglas spruce, Engelmann's spruce, and the white and black pines.

ZONE OF WHITE-BARKED PINE.

The Crest Line Zone is the uppermost of the forest divisions of the Cœur d'Alenes. It is composed to the extent of 85 per cent of two species. They are Patton's hemlock and the white-barked pine. The lower limit of its range is 1,700 meters (5,600 feet); the upper would doubtless be the timber line did any such exist in this region. The forest here is not continuous. It occurs in large or small groves separated by grassy tracts. Very often over large areas but scattered individuals occur. There is not much undergrowth. Some huckleberry shrubs and the two species of mountain ash (*Sorbus sambucifolia* and *S. occidentalis*) which occur in this region constitute the greater part of this. Very few windfalls are seen, and in general the forest is park-like, as in the zone below. By reason of its exposed position a great deal of the ground in the Crest Line Zone is rocky and the soil poor.

The second classification of the Cœur d'Alene forests is based upon tne age of the majority of the trees, those which form the bulk of the timber growing upon any particular area. This is wholly dependent upon the time that has elapsed since the forest was burned, and while altitudinal limits have nothing to do with this we shall see farther on that by far the largest and most destructive fires occur in the Yellow and White Pine zones. The four subdivisions I will define thus:

Old Growth.—Areas on which no fires destructive to the forest growth have occurred within the past two hundred years.

Second Growth.—Areas which have been wholly or partially burned over inside of two hundred years, but on which no fires have occurred within the past seventy-five years.

Young Growth.—Areas on which the timber has been destroyed by fires within seventy-five years, but where none have occurred during the past thirty-five years.

Recent Burns.—Areas burned over within the last thirty-five years, and on which the destruction of the timber has been from 65 per cent to total.

The Old Growth covers the smallest areas in the Cœur d'Alenes. It is most common in the Crest Line and Yellow Pine zones and least in the White Pine, for reasons to be stated farther on.

The Second Growth comprises the major portion of the growing timber fit for lumbering purposes. It is most abundant in the White Pine Zone.

The Young Growth and Recent Burns are more plentiful and of larger extent in the White Pine Zone than elsewhere.

FOREST DESTRUCTION.

Under this head we will consider the agencies which are now operating to destroy the forests of this region and the remedies which, if applied, would have a tendency to check them.

The remarks to follow will in a large measure fit the conditions which prevail throughout the forest regions of Idaho, Washington, and Oregon, and if the remedies to be proposed would secure the desired result here they would do the same elsewhere where like circumstances exist.

The Cœur d'Alene forests are in process of rapid and total extinction. The slow agencies of nature which are constantly destroying but as constantly replacing are augmented by the efforts of man, who, with all the means of destruction at hand, tears down the work of centuries, but gives no thought toward the rebuilding of the fabric.

The forests of the Cœur d'Alenes in all the accessible portions are becoming mere skeletons of their former state, and soon the last vestiges will be swept away and nothing remain but blackened logs and stumps to mark the former site of the densest forest between the Cascades and the Mississippi.

The popular mind, fostered by the newspapers of the West, refuses to believe that the forest region of the Pacific Slope is other than inexhaustible. It is a most pernicious idea, and one which is largely responsible for the apathy of popular opinion upon forest preservation in the West. Journals and newspapers in every section, in attempting to exhibit the natural advantages of their several localities, will, if in a forest region, invariably lay stress upon the inexhaustible supply of timber fit for lumbering and other purposes, absolutely ignoring the fact, patent to every careful observer, that in a country so rugged and difficult of access as that formed by the ranges west of the Continental Divide only a very small proportion of the forest covering can be reached economically, and that the accessible localities are being denuded as rapidly as the ingenuity and carelessness of the inhabitants can accomplish it. So far as the Cœur d'Alenes are concerned, the forest is fast disappearing, a small percentage into lumber, but most of it into smoke and ashes, and generations will pass before what has been and is being destroyed can be replaced, even with the most fostering care, upon the denuded areas by the General Government or by individuals.

It is about thirty-four years since the Cœur d'Alenes became at all accessible, by the construction of the Mullan road. The age of the Young Growth upon hundreds of thousands of acres proves that the forest, at least in the Yellow and White Pine zones, was practically intact before that time. Upon the completion of the road a constant stream of immigration poured into Oregon and Washington by this route. The heavy and dense timber through which the road led for so many miles gave a gloomy aspect to the region, and the torch was freely applied "to let in more air and sunshine." The dry season was the time of year when the immigration was the heaviest; that was also the time of year when the forest was in prime condition for burning, and that advantage was taken of this circumstance the large tracts of young growth attest.

The next well-marked epoch in the annihilation process came with the building of the Northern Pacific Railroad. The right of way was cleared by fire whenever the timber was in a condition to burn. I passed over this road in September, 1883, and there were then two almost continuous lines of fire along the track throughout Idaho. It is true the road did not run through the Cœur d'Alenes. The fires were in the valley of the Clark Fork, but they extended from that region into the basin of the North Fork of the Cœur d'Alene and wrought immense destruction there.

The next and last stage, which is still in active operation, came when the great ore deposits in the Cœur d'Alenes were discovered. Thousands of prospectors flocked into the country then, and the forest fires raged in hundreds of localities to clear away the dense growth of timber and shrubs, which very materially interferred with the work of the prospectors seeking the mineral-bearing lodes. As the mines began to develop, fuel and lumber were needed. The choice parts of the forest were cut into, débris took the place of the green tree, and fire, coming later, finished what the ax had spared. In 1884 I passed through the Cœur d'Alenes into Montana. In spite of the many previous fires, there were miles upon miles of primeval forest. In this year (1895) along the same route there was not a single foot that the fire and ax had not run through and the larger quantity had been uselessly and totally destroyed. The site of the former flourishing forest was now occupied in part by a mass of blackened stumps and overthrown trees, in part by the débris left behind by the sawmills, long since departed, for there were no more logs to saw, and in part by coarse weeds or a struggling young growth endeavoring to gain a foothold along the steep mountain sides, but invariably fired as often as a sufficiency of undergrowth accumulated.

In the sections where no settlements exist the ax and the railroad as destructive factors are eliminated, but the most powerful of them all, the forest fire, remains and rages unchecked.

It is true that the needs of the people living in and developing the region demand fuel, lumber, etc. There would be an abundance to furnish all necessary supplies of this sort for ages to come if the forest was properly used. But in place of putting in practice an intelligent and careful system that would guard against waste and permit the growing timber to recuperate, methods are in vogue such as would have been especially devised for the purpose of laying waste as great an area of forest as possible in the shortest time.

From an intimate knowledge of the Cœur d'Alenes, obtained during a residence of ten years in the immediate neighborhood, I do not hesitate to affirm that 50 per cent of the accessible merchantable timber of the Cœur d'Alenes is absolutely destroyed; that of the remainder 20 per cent has been more or less culled, leaving only 30 per cent in good condition. All this within a period of thirty-four years, and of these only twelve years represent settlement and development.

Judging from these data, how long will the remainder last, without some system of protection?

Few persons consider the time required to replace a forest of the sort that covered this region upon the advent of settlements. Those who are especially active in destroying it clearly never do. Let us take the most commonly utilized trees for examples. To produce mature lumber—that is, logs that will saw economically and furnish a product reasonably durable in character—requires for the yellow pine an average of 175 years, for the white pine a period ranging from 200 to 300 years, for Mertens's hemlock an average of 275 years, for the cedar 200 to 250 years, for the Western tamarack 150 years for rough lumber, 300 to 350 years for the clearer and more valuable product, and for the Douglas spruce an average of 200 years. The tamarack and the Douglas spruce are cut for railroad ties while young. Few trees are fit for this purpose under 50 years of age. A glance at these figures will show that no denuded area will again produce valuable timber for generations to come. It may be said that there is a young growth in various stages, which is continually producing mature trees. Accepting this, the question arises, Is this source of supply sufficient to meet the constantly growing demands? It is perfectly clear that it is not. Sawmills are continually exhausting the forests in their localities and laying new areas under contribution. Small lumbering plants and tie-choppers' camps are being moved from place to place to find fresh and untouched regions; and, so far as we know, not one of the areas denuded since the advent of the sawmill has as yet recuperated sufficiently to yield a further supply of merchantable logs.

However rapid the destruction may be from the ax and the saw, it would still require a very long time to create any appreciable want of suitable lumbering material on the Pacific Slope if only these two means were employed, but added to them are the fires, and they spare neither old nor young growth.

There are two principal agencies by which growing timber is destroyed—the operations of nature and those of man.

The natural agencies operating in the Cœur d'Alenes are in part those of the meteorological order and in part those which act as diseases of the trees. Of the former there are four, rain, snow, lightning, wind; of the latter, one, fungi.

The action of rain, snow, and wind is more or less synchronous, according to season, and operates throughout the year. The lightning is more local, and limited to a few months during late spring and summer. The destruction from the first three climatic agencies, resulting from the enormous precipitation, is immense. The vast quantities of débris in the shape of fallen or broken trees, which litter the forest in all directions, prove this. The storms that bring the rain or snow are nearly always accompanied by strong south or southwesterly gales. Owing to the broken character of the mountains, the valleys are sheltered from the direct force of the wind, which is only felt in all its strength on the high summits of the ridges. In the valleys the wind comes in series of severe gusts of longer or shorter duration. The heavy rains loosen the soil and humus about the roots of the trees, and their great height affords a leverage by which the largest tree is easily overthrown by a comparatively small exertion of force. The ease with which a tree is thrown down depends, also, largely upon the depth to which the roots penetrate. There are but two species of conifers of general occurrence in this section which strike root deep enough to offer a fair degree of resistance to the wind. They are the cedar and Western tamarack. The cedar is short in stature and does not offer much leverage; the tamarack grows tall and, as it does not readily yield at the root, is frequently broken off in the trunk. We therefore find the greatest destruction due to these agencies in the Intermediate or White Pine Zone.

The operation of the phenomenon that I have named the dominant precipitation point (see page 15) is shown here. It has already been mentioned that the winds which accompany the storms are felt throughout the valleys as powerful intermittent gusts. The greater number of these are observed to have a certain determinate direction for each season, breaking down the forest persistently and repeatedly in the same locality during successive storms and leaving other portions untouched. As the ridges by their trend determine in the deflection of the air currents the angle of impact of the wind in the valleys, it will be readily seen that a change in the general direction from which the storms come will involve a corresponding change in the deflection of the air into the valleys, which, in turn, will spend its force upon another part of the forest. If the storms came always unalterably from the same point, we should have long, tortuous passages cut through the forest in certain directions, but owing to the oscillating movement of the point from which the storms come we find areas which have been partially denuded in all stages of repair and others which show all degrees of destruction.

The agency of snow in destroying the Cœur d'Alene forests is seen in the great number of broken trees, both young and old, which one meets constantly in traveling through the timber. To successfully resist the snow, it is necessary the tree should have a vertical stand. Even a slight degree of inclination is pretty sure to end in the uprooting of the individual by the weight of the snow which will accumulate on the crown during the storms of early winter.

Snow slides occur at various places, especially around the high, bare peaks—such as Stevens, Wiessner, and Sunset—but they are insignificant and not at all dangerous, except where the timber has been destroyed. The occurrence of destructive snow slides in the settled portions of the Cœur d'Alenes is a direct consequence of forest destruction in those localities. On the areas where it is untouched no slides can occur. The snow is firmly held, melts slowly, and there are no bare spots on the slopes or on the summits where a loosened mass can acquire momentum.

The lightning operates by following the trees to the earth and firing the humus, or, in cases where they are dead and standing, the trunks or limbs are set on fire. Many of the fires which rage in the Cœur d'Alenes are ascribed to this cause. The supposition, however, is in the main fallacious. There are occasionally during summer high winds accompanied by electrical phenomena, lightning and sometimes thunder without rain. If lightning strikes a tree during such a storm and fires the humus, there is a probability of a forest fire. The largest number of electrical storms, however, are accompanied by downpours of rain which drench the humus and the foliage of the conifers so thoroughly that they can not burn.

Diseases of the trees come last among the more prominent of the natural influences which destroy the forests in the Cœur d'Alenes. They are the results of the attacks of various kinds of fungi. Every species is subject to them, but some more than others. Of the varieties that are particularly useful the white pine is, perhaps, more liable to such attacks than any other. Great bodies of this pine are often attacked simultaneously over considerable areas by some obscure fungous disease and invariably succumb.

We come now to the cause of the most extensive depredations on the growing forest—man. He employs two potent weapons, the ax and saw and fire. The methods and the motives of and for his work on the timber are infinitely varied. Among the former, sawmills and logging operations stand preeminent. There is not now as much activity in these industries throughout the Cœur d'Alenes as there formerly was. The reason for this is partly to be found in the diminishing supply near the centers of consumption and partly in the failure of various parties to obtain the timber-cutting permits they have sought, which, if granted, would have opened up to them the best portions of what yet remains comparatively untouched. There are now no very large sawmill or logging concerns in operation in the Cœur d'Alenes. The largest and most numerous are at Harrison, at the outlet of the Cœur d'Alene River into Lake Cœur d'Alene. They obtain their logs partly from the St. Joseph region, partly from the Cœur d'Alene and North Fork valleys. At Cataldo, 3 kilometers (1.7 miles) above the old Cœur d'Alene Mission, there was until three months since a mill for the manufacture of shingles. They obtained their logs wholly from cuts along the valley of the North Fork. This plant burned down and is not yet rebuilt. There are, or were recently, a few small mills in the valley of the North Fork sawing lumber for local demands, also a few in the South Fork, all mere portable concerns. There are no sawmills in the St. Mary basin and none in that of the St. Joseph. In the former no logs are cut above the point where the river enters the canyon; on the St. Joseph logs are cut wherever opportunity is afforded. The large sawmill lately built at Spokane, Wash., will in the near future make itself felt as a consumer of the Cœur d'Alene forests.

Among other demands which make serious inroads into the timber are those for railroad ties and telegraph poles. None but young trees are used for these purposes, and none of larger diameter than can be used in their full diametral growth. The telegraph poles are cut altogether from the cedar, the railroad ties from Douglas spruce and tamarack. None are sawed except bridge and switch ties; the others are hewed from the tree. This makes the employment of large trunks for this purpose impossible. As ties made from the soft timber of the Pacific Coast conifers are not durable when placed in contact with the soil, they soon decay and require frequent renewal. Vast quantities of young timber are continually cut to meet this never-ceasing demand.

In logging, or cutting timber for any purpose, no attempt is made to spare the forest. A tree is felled in the direction which will be most convenient, without regard to the number it will crush in falling. The best parts only are used—tops, etc., are left to rot where they fall. The tie-chopping camps are the worst in this respect. As they can utilize more of the trees in a given space than the loggers, they also leave more tops and litter behind. This furnishes an excellent nidus for the coming forest fire to work in. Wood choppers, if in a region where trees are plentiful, pursue the same method. The straight, clear parts of the tree only are utilized; the crown is rejected, because it splits harder and requires time to trim up.

The clearings made for agricultural purposes really are the least destructive of timber, though one would suppose it would be the reverse. That is because it is an impossibility for one man to clear a farm in the White Pine Zone of sufficient size to support a family within the time of one generation. The clearings are mainly confined to the Yellow

Pine belt, and when settlements are made within the White Pine Zone the open meadow lands are universally chosen.

We come now to the most destructive of all the means used in exterminating the forests not alone of the Cœur d'Alene region, but of the Pacific Slope in general—the element of fire. The forest fires of the far West are very different affairs from those that ravage the upper Mississippi Valley or the Eastern States. Did they carry with them the same menace to life, we should soon see concerted efforts to abate the evil. Forest fires have always raged in the Cœur d'Alenes. The oldest growth of forest shows blackened stumps buried under the accumulated débris of centuries. When one digs down in the soil charred wood is often turned up from the depth of 1 meter (40 inches) or more. The forests of the past were doubtless fired in the main by the Indians, accidentally or purposely, or both. The areas, however, which were burned over each season were insignificant; in most sections fires manifestly did not occur during centuries.

The action of the fires in each of the forest zones is in a manner peculiar to each section, depending upon the means whereby it spreads. Its destructiveness, always considerable, is proportional to the amount of humus which covers the ground and to the free or interrupted access of a draft or wind. The fires of the White Pine belt are by far the most destructive from every point of view and very much more numerous. Owing to its sheltered situation, the progress of fire is here slow. It is not difficult to walk away from a fire as it advances. One can ride through a burning forest, as I have done many times, and suffer no other inconvenience than a covering of ashes and dust. A slight amount of clearing around a cabin or house is ample protection. It only becomes dangerous in the rare instances when a high wind fans the flames, or when the fire runs through an area previously burned over on which the dead timber is down. It then sometimes creates a strong draft or suction of its own, which sends the flames through the forest at great speed and annihilates everything in its way. Such instances are rare, and the fury of the sea of flame is soon over. The quiet and slow burning is the rule, and but for the volumes of ascending smoke an observer at a distance would not suspect the perhaps near presence of a great forest fire.

The fire in the White Pine belt spreads principally by burning the humus. There is a covering of this material ranging from 4 cm. (1.6 inches) in depth to 50 cm. (20 inches) or more. This rarely burns with a flame. It is a process of slow incineration of the mass at a red heat. If the fires ran through the forest with the same speed as in the East, every vestige of timber would have been swept off long since. After the fire has once obtained a firm lodgment in the humus it becomes an exceedingly difficult matter to extinguish it. I have known it to burn continuously for two months under the snow. As the line of incineration spreads through the forest, it encounters the roots of the trees.

In the majority of instances these are not burned, they are simply cooked, and the lower portion of the trunk, which is always more or less buried in a mass of dead and decaying pine needles, suffers the same fate. Only when a tree is reached having pitchy roots or gum cracks does it burn up, and then seldom completely.

The fire-resisting power of the trees, both in species and individuals, varies greatly. The factors of safety lie in a thick, nonresinous bark and in roots which penetrate deeper than the lower limit of the humus. Among the trees that occur in the White Pine belt the Douglas spruce resists fire the longest and Mertens's hemlock the least.

The fires in the Yellow Pine Zone spread with greater rapidity than in any of the other sections. The country is open and the ground more or less covered with grass, through which the fire runs. As the growth of grass is thin, the duration of the fire in any locality is short, and neither the yellow pine nor the Douglas spruce suffers very much the first few times. Where dense groves of black pine and tamarack exist there is a thick layer of pine needles, and the effects of the fires on them are much the same as in the White Pine belt. When the fires occur among the subalpine firs or along the crest line of the ridges, there is commonly a strong breeze accompanying them and fanning the flames. A clean sweep is pretty apt to be made in such cases. The subalpine fir does not well resist the fire, as the resin vesicles in the bark burn readily and cook the wood.

The after results of a fire on the timber are various. In the White Pine belt every tree that has been exposed to a fair contact with the smoldering, redhot humus dies. In the Yellow Pine section the tamarack and Douglas spruce trees that survive are almost certain to develop gum cracks, which unfit large portions of the tree, if not the whole, for use. The yellow pine develops pitch streaks and spots where the fire has touched the bark most severely, but in general this tree, owing to its very thick and nonresinous bark, suffers less than any other species. The gum cracks and pitch streaks which come as the after effects of the fires, even if the tree is not killed, pave the way for a burning of the individuals so affected at the next conflagration.

The trees in the White Pine belt soon begin to decay after the fire has passed through. The hemlocks always rot first at or closely below the lower portion of the crown of the mature trees, the others at the root. Two or three years after a fire the tops of the hemlocks begin to drop off and the tall, dead spires of white pine, spruce, fir, etc., begin to fall down. In six or seven years from the time the fire first swept through there is a sufficiency of débris on the ground to furnish material for a fresh conflagration. In the meantime a growth of saplings has sprung up, and the forest has become so dense with the mass of uprooted trees and vigorously growing saplings as to be quite impassable. For the second time fire is applied. There is now no humus, only woody litter. The fire, fanned by the free access of the air over the denuded area, burns fiercely, and windfalls, standing dead trees, and young growth are all swept away together, leaving nothing but a light covering of ashes and a few blackened stumps.

In the Yellow Pine section, as before explained, the trees are not fire-killed as extensively as in the other sections, but the action on the young growth is the same. The second fire therefore frustrates any attempt of nature to replace the cut off or burned up older growth by a new one.

The forest is replaced by nature abundantly and surely if not interfered with. Within a few months after a "first burn" of a forest area in the White Pine Zone, there will be seen young plants of various species of willow and ceanothus springing up in great numbers from the denuded soil. In places where the humus was not totally destroyed seedlings of different kinds of conifers which grew nearest the burned area begin to show themselves. After three or four years the shed and decaying leaves of the willows, ceanothi, and the annuals that are coming in have formed a very thin humus, which appears to be essential to the germination of the seeds of the conifers, which now increase rapidly, and in a few years the shrubby vegetation has given place to a thriving young growth of trees. At the same time most of the dead timber killed by the previous fire has fallen down.

When the timber is removed by a second burning, the barren soil parts more readily with its moisture. Owing to this cause many places, especially those with a southern exposure, become too dry after a fire to again allow the growth of conifers. We find such places everywhere along the valley of the South Fork, the upper St. Mary, and in the zones of the Subalpine Fir and the Crest Line. The wide expanses of grassy slopes at high elevations are probably due to the exsiccated nature of the soil during the summer months. One sees old burned stumps in many localities at these elevations, and their presence proves incontrovertibly the existence of a heavier forest growth in past times.

It would be practically impossible for human efforts to replant successfully any considerable portion of the burned forest tracts in the Cœur d'Alenes. In the first place, the ground must be sheltered from the direct rays of the sun, not only to permit the germination of the seed, but also to retain a sufficiency of moisture during the dry season. Next, the seedlings or saplings must stand close enough to resist the crushing effects of the great quantities of snow piled on them during the winter. Observation proves that a dense growth does not suffer in the aggregate from this cause as much as one that is open.

On an acre of ground in one of the sections where the forest is in process of restoration a half million seedlings 15 cm. to 20 cm. (6 to 8 inches) high is a common occurrence. On shady slopes with a northern exposure I have seen them set so closely that every acre bore millions. Young trees 4 to 5 meters (13 to 16 feet) high form such dense groves in many places that it is impossible to force one's way through them without chopping. It is only by growing in such masses that the species in their early stage stand a chance to survive the destructive forces of wind and snow.

In the belt of Yellow Pine there is always more or less of a grassy covering, which is replaced very soon after being burned. This acts the part of the humus in the White Pine Zone and favors the germination of seeds.

The species of conifers that come up over the burned areas are the same as those which grew there before, the only variation being in the relative number of individuals of the various kinds upon a certain measure of ground. Thus, upon a piece of bottom land previously covered to the extent of 70 per cent by the white pine and hemlock the black pine may come in and form perhaps 90 per cent of the total stand, or hemlock may crowd everything else out on the slopes, or the white fir do the same. This, however, is not lasting, for eventually the same balance which existed before the fire is restored.

The principal causes of forest fires in the Cœur d'Alenes are prospectors, railroads, timber cutters, farmers, camping parties, and maliciousness.

First come the prospectors, as the originators of the larger number of fires. The dense forest and the deep humus covering the soil are great hindrances to prospecting. To clear away these and expose croppings or "float" from the mineral-bearing veins which may exist in the neighborhood the forest is fired. When a mineral claim is located, it is customary to employ fire to help in stripping the ground, if heavily timbered; that it spreads does not matter, in fact no attention whatever is given to it. When it is considered that the Cœur d'Alenes are seamed with mineral-bearing lodes, that many men are engaged throughout the summer in searching out these veins, and that they never hesitate to fire the forest to expedite their work, it need surprise no one that every season hundreds of forest fires are started in every section where mineral is known to exist. While each of these may not cover an extensive space, collectively they form a very large area. The first burning, however, does not suffice for prospecting purposes. The fallen trees soon render the country more difficult of access than ever. It is only when a region is given a second burning that the ground is well cleared for years to come, and the prospectors know this only too well.

Railroads come next as the originators of fires. No line is ever constructed through the timber that is not flanked by two strips of forest fires so long as the timber lasts in proximity to the road. During the time of construction the right of way is cleared by fire whenever practicable; it spreads from the construction camps, and no efforts are made to check it, except so far as relates to the safety of that particular camp. When the line is in operation, sparks from engines—never provided with efficient spark arresters—start extensive conflagrations. Both sides of an embankment a few years old, and the partially or wholly cleared right of way always support large quantities of herbage in the shape of annual and perennial plants. In late summer all this is like a mass of tinder, ready to burst into flame upon the application of a spark. The railroads themselves often suffer severely from the fire, kindled through their own carelessness or negligence. Bridges are burned, ties and wood destroyed; still, little effort is put forth to check the evil.

Timber cutters come next as factors in the destructive processes. If they do not absolutely kindle as many fires as do those we have already noticed, they certainly contribute more toward the effective preparation of the forests for the coming conflagrations than do the others. The forests are filled by them with litter from the cut trees, the upper portions of the trunk and the crown, which are never utilized; broken and splintered trees of all ages and sizes, destroyed by the careless felling of the trees that were used; large trees cut down and sawed into logs, but rejected for various reasons; in short, all the débris a large dense forest will furnish. Such a mass of inflammable substances gives an excellent opportunity for a hot, destructive fire, and it is sure to come sooner or later. Occasionally fires are set to cover up plunderings of trespassers upon the public timber, and they are common enough in all localities where large quantities of lumber are cut from public lands.

Settlers upon agricultural lands within the forest areas do their share toward needlessly destroying the timber. We will exclude all fires set for the purpose of clearing the land to render it tillable. It never stops here, however, except by accident. If the conflagration spreads from the clearing to the neighboring forest, no one tries to stop it or cares in the least how far it extends so long as it does not endanger the individual's property. The greatest danger from this cause lies in the sections where the settlers endeavor to depend upon stock raising for their support. Their summer range here is the forest, where the grass growth, at least in the White Pine Zone, is exceedingly scanty. By burning the forest they reason that a larger supply of grass will be obtained. This is true, at least partially. Many fires are started with this object in view.

Camping parties often carelessly neglect to extinguish their fires in breaking camp. There is a local law applicable to this in the Cœur d'Alenes, which, however, nobody ever dreams of enforcing.

Maliciousness adds in a slight degree to the causes of forest fires. Instances are known where parties have fired the timber out of morbid curiosity to see it burn and to see the flames run to the top of the tall, lichen-draped trees.

BURNED AREAS.

The forests in the Cœur d'Alenes are honeycombed with burns in all directions and of all sizes. It is impossible to travel anywhere without meeting with these dead and blackened remnants of what was once a vigorously growing forest. The saw and the ax have been as nothing compared with the fires. I do not hesitate to assert that for every foot of lumber, board measure, put to proper uses in this region 100 cubic feet of timber have been destroyed by the fiery element or needlessly wasted in the tree. The burns of largest extent have been in the Yellow Pine districts. It would be a difficult matter to find a body of 500 acres in the whole of this zone which has not been visited by fire within the past thirty-five years. If the damage done here was as great and complete as elsewhere, there would now be nothing left of this but charred logs. Luckily, however, this, the most accessible portion, suffers the least. It is in the White Pine belt that we find the destruction in its widest sweep. I would here call attention to the map accompanying this report. I have endeavored to mark on it all the large areas where more than 50 per cent of the growing timber is destroyed by fire. Commencing in the southern part with the St. Mary basin, we find in the upper portion of its valley an area, approximately 25 kilometers (15.5 miles) north and south and 35 kilometers (22 miles) east and west, upon which the destruction of the old growth has been from 70 per cent to total. The bulk of this was burned about sixteen or seventeen years ago. A young growth has covered the oldest burns, and this has in turn been destroyed over about one-fourth of the area.

Coming down the valley, we find minor burns everywhere. They range in size from an acre or two to tracts of 300 or 400 acres. An exception to this is a large tract of mostly Old Growth, situated between the Santianne and a line drawn east and west through a point about 4 kilometers (2.5 miles) south from Emerald Creek from the west divide to the St. Mary. Burned spots occur over this area also, but they are not large in the aggregate. When the canyon portion of the St. Mary is reached, most of the burns are on the west bank in the Yellow Pine belt. They are, as before, of varying size, dotting the country here and there and separated from each other by bands of living forest. On the east bank the open Yellow Pine belt, which follows the immediate vicinity of the stream, soon gives way to a section of the White Pine Zone, remarkable for its excellent state of preservation. This tract occupies the triangular space which is inclosed between the St. Joseph and the St. Mary on the east and west, the point of junction of these two rivers on the north, and the Elk range for the base in the south. The best and most valuable timber, as well as the easiest of access of all in the St. Mary basin, is situated here and on the previously mentioned area north from the Santianne.

Coming to the St. Joseph basins, we find that the burns are of the scattered kind. Small tracts, from a few acres to 3 or 4 square miles, separated by larger areas of green timber, are found throughout. On the whole, the St. Joseph region has suffered very much less than any other portion of the Cœur d'Alenes. This is entirely due to its general inaccessibility and remoteness from the highways of travel and centers of population. In the low country around Lake Cœur d'Alene and its easterly extensions up the valley of the Cœur d'Alene River we enter upon the classic grounds of the great burns of this region. Through this low, broken, undulating country came the two routes of the military road constructed by Capt. John Mullan in 1859 and 1862 and in later years a branch line of the Union Pacific Railroad. There has been in consequence no lack of opportunity for the spread of fires, and the region has always been and is yet a grand starting point for the conflagrations which are sure to occur each summer.

This broken region consists, topographically, of the foothills of the basal ridge of the North Fork basin, the only area of its kind in the Cœur d'Alenes. A line drawn from Rathdrum, Idaho, to the Old Mission, on the South Fork of the Cœur d'Alene River, would very nearly bisect it. We find here a mingling of the zones of the Yellow and the White Pine—an interlacing of long lobes which extend from the one into the other. Originally the forest was exceedingly dense over the greater portion of this area, and being easy of access it was one of the most valuable parts of the region for lumbering purposes. Hundreds of fires have sadly decimated it during the past twelve or fourteen years. The Yellow Pine has not suffered so extensively, owing to causes already explained, but the abutting and interlacing portions of the White Pine Zone have been frightfully ravaged. From this tract as a central point the fires have spread many kilometers north and south into the adjoining mountains. Excluding all portions to the east of the Old Mission for the present, there is in this tract an area of about 50 kilometers (31 miles) from east to west and as much from north to south upon which 65 per cent of the forest has been destroyed by fire. The remaining 35 per cent represents yellow pine principally. As this foothill region is especially liable to conflagrations, the inroads of sawmills, and the clearings of settlers, a few years longer will solve the forestry problem here.

Proceeding up the valley of the South Fork, we come into the center of population of the Cœur d'Alenes. Between the fires and the sawmills the valley is pretty well cleared of its forest. From the Old Mission to the summit of the Bitter Roots, a distance of 60 kilometers (37 miles), and extending north and south, with an average width of 18 kilometers (11 miles), fully 90 per cent of the timber is gone. Comparatively little of it was utilized; most of it burned up. Much the larger part of the valley is now entirely destitute of sizable timber. What is left we find in the wet canyons, where the abundance of water in the humus has acted as a bar against the spread of the flames. The young growth stands no chance here. As soon as large enough and dense enough to burn it is certain to be fired.

Coming into the North Fork basin, we go away from the highways of travel and would expect to find a less amount of destruction. It would be so were this tract not surrounded by a series of points whence conflagrations are sure to come each year, everyone eating a little deeper into the forest than did its predecessor, In the southeastern part of the basin, where the gold-bearing areas are situated, we find about 80 per cent of the forest destroyed. These burns date partially to the time of the old ones of the South Fork valley, with which they connect in many places, and in part to the conflagrations started by the army of gold seekers which overran the country when it first became generally known as a mineral-bearing region in 1883 and 1884.

Going north into the basin, one encounters interrupted burns at frequent intervals until the northern portion is reached. Here are found those which had their origin in the fires kindled in the valley of the Clark Fork at the time the Northern Pacific Railroad was built. The area covered is not known to me, but it is large, for the burns follow the valley of the Clark Fork from Thompson to Lake Pend Oreille, a distance of 115 kilometers (69 miles), and the fire has eaten into the timber of the North Fork basin in thousands of places, extending in some localities as much as 30 kilometers (19 miles) southwest from the river.

Changing to the western side of the North Fork basin, we come to the burns which have had their origin in the mining camps on the east shore of Lake Pend Oreille. A strip of country 45 kilometers (30 miles) from north to south, and averaging in width from 8 to 16 kilometers (5 to 10 miles), has been laid waste here to the extent of about 75 per cent.

Going farther south, we reach the northern limit of the burns which have come from the region of the Cœur d'Alene valley. They have not penetrated very far into this part of the North Fork basin. Owing to the slow progress of forest fires, the spread of one having its origin in the South Fork valley, or along the Mullan road, would only, except in unusually dry seasons, reach this part before the quenching fall rains commenced. The most valuable portions of the growing timber are found here upon an area which extends eastward to the main river and northward to the central sections of the basin. I estimate that upon a tract of about 400,000 acres 10 per cent of the forest is destroyed by local burns, an insignificant amount when compared with the condition of the timber in other localities.

In estimating the percentage of timber destroyed and standing it is pertinent to consider what amount of merchantable timber of the different species of conifers grows upon an acre. This varies so greatly that it is difficult to give even an approximately correct estimate. I would consider for the best class of bottom lands in the White Pine belt an average of 30,000 feet, board measure, to the acre a low estimate. It might be divided thus:

	Feet.
White pine	17,000
Douglas spruce	4,000
Tamarack	3,000
Cedar, spruce, etc	6,000

Where cedar predominates it might rise to three or four times this amount. This estimate includes only trees fit for saw logs.

In the Yellow Pine Zone a fair acreage would be 7,000 feet, board measure, divided about equally between yellow pine and Douglas spruce to the extent of 75 per cent, the remainder tamarack. However, as before remarked, the conditions of the forests are so unequal, owing to climate, etc., that no just estimate as to the total amount any particular area carries can be made from a general average.

The accessible portions of the Cœur d'Alene forests theoretically include the whole; practically they do not. The amount that can be reached will always depend upon the urgency of the demand and the prices of the forest products in the particular region. There are no physical difficulties in the way of gaining access to all parts which can not be readily overcome; the cost is the main factor. The total of the bottom lands in the valleys and canyons is probably not the one-hundredth part of the superficial area of the region.

The future of the forests of the Cœur D'Alenes can be easily predicted unless a successful system of adequate protection against wanton destruction is afforded. If in the short space of thirty-five years 50 per cent of the accessible timber has been totally destroyed, it requires no great calculation to figure out the destiny of the other half. It must be recollected that only twelve or thirteen years of this period have been marked by industrial development in the region.

FOREST PRESERVATION.

Putting aside wholly the question of sentiment and looking at the matter from an economic standpoint, there is not the slightest question that the forests of the Cœur d'Alenes should be preserved.

The forest should be preserved because it is a source of lumber and fuel. The greatest wealth of the Cœur d'Alenes is in its mines. To exploit the mineral treasures of these mountains successfully requires an adequate amount of lumber and fuel.

When the home supply gives out it must be imported. That means a very long haul, for the forests of Montana, never extensive, are fast drifting toward the same condition in which the Coeur d'Alenes are found. We have seen that a very long time is required before a forest once destroyed will arrive at sufficient age to yield marketable logs. The young growth of the Coeur d'Alenes will not reach this state, even with the best of care, within the next three generations. There is all the more reason, then, why that which remains of the Old and Second growths should be used legitimately—that is, with all needlessly wasteful methods rigorously eliminated.

The forest should be preserved for climatic reasons. The clearing away of the forests subjects all the agricultural lands in the valleys to much greater temperature variations than they previously experienced. The days will be warmer, the nights colder. The increased diurnal temperature is no compensation whatever for the lower nocturnal. It means a freer evaporation from the soil and consequent desiccation, and a greater radiation into space of the heat that the earth has absorbed during the day, and therefore more frosty nights. Not only are the valleys within the mountains affected, but the phenomena of frosty nights during the summer will make itself felt more severely in the valleys of the plains which have their head in the adjacent mountains. The living forest warms the cold night air that filters through it during the night. As the sun nears the western horizon on a clear afternoon an interchange of air between the crests of the ridges and the bottoms of the valleys takes place. The cold air being the heavier descends, and sinks into the lowest depressions in the ravines and canyons. The heated air of the valleys ascends by the slopes. In a dense forest where free radiation is prevented the mean temperature of the several seasons varies but little either during the day or night. Let us suppose the mean summer temperature in a section of normal forest in the valley bottoms to be 6° C. (43° F.) at water level in the soil a meter or two beneath the surface. I think this temperature approximately correct for elevations of 700 to 900 meters (2,300 to 3,000 feet). During the night the air temperature to a heighth of 50 to 90 meters (160 to 300 feet) above the surface will not be more than 2° C. lower. The cold air from the crests filtering through such a forest is warmed near the earth and emerges upon the open meadow lands at a considerably higher temperature than it otherwise would. Frosty nights are doubtless averted in many instances through this means and the severity of others much mitigated.

The timber should be conserved for the part it plays in regulating the drainage of the annual precipitation. Vast quantities of snow fall every winter in the western ranges. Rain storms occur frequently during the late fall and early spring and load the mountain snows with water. The amount thus held by the snow is sometimes immense. I have melted the snow on the mountain summits in the month of March and have found it in some seasons so heavy with absorbed water that from a layer 18 cm. (7 inches) in depth 10 cm. (3.8 inches) of water would be obtained. In the spring the snow disappears much faster and more suddenly on the open and exposed places than it does where afforded protection by the shady forest. This precipitates a great volume of water into the streams and destructive freshets occur. During the summer the streams become abnormally low and the supply is insufficient to serve the purposes for which it is needed. Alternate freshets and scarcity of water in the streams are the universal results of the cutting away of the forests in all portions of the world, and are too well known to be dilated upon here. In the Cœur d'Alenes and indeed every where throughout the Pacific Slope an element not so universally experienced comes in, namely, fire.

The streams are supplied in two ways, by springs and by slow percolation of the water held back in the moss and humus and in the top soil among the multitude of roots that ramify throughout it. The springs issue forth from the rocks, their water representing the drainage of the precipitation that has fallen upon the crests and rockier portions of the ridges and which has sunk into the cracks and crevices of the strata to become visible again at lower levels. A very large proportion of this water comes from the snow which falls in the zones of the Subalpine Fir and the Crest Line. The slower the snow melts here, and by far the larger part of the precipitation these zones receive comes in the shape of snow, the higher will be the upper level of the water line and the more will the annual amount discharged by the springs be equalized.

The amount of water held back in the humus and top soil is immense. In the two zones above mentioned there is but a small depth of this, but in the White Pine Zone it is very thick. This section is the great water reservoir of the Coeur d'Alenes. Not only does it hold back great quantities of water by its absorbtive power, but the denseness of the forest growths prevents direct evaporation from the surface, and the widely spreading rootlets, together with the other multitudes of obstacles it interposes to the free flow of water in its heavily wooded canyons and bottoms, hold back great volumes. When a fire devastates a region here, these conditions are changed. The sponge of humus is destroyed; the mold in the top soil is burned off, leaving behind the siliceous portions which do not long retain water, and the shade is gone, exposing the ground to the direct rays of the sun with their baking and desiccating power. When spring comes, the snow that has fallen upon the burned-over areas in any of the forest zones melts with great rapidity. As there is nothing to hold back the water until its absorption into the soil has taken place, it rushes off on the surface in torrents to the plains below. The small quantities that sank into the soil have drained away when summer comes, and a scarcity is the consequence. It will therefore readily be seen that if the mountain streams or lakes are ever to be utilized as reservoirs for water to irrigate the plains areas it will be necessary rigorously to preserve the primary reservoirs—that is, the forests.

It is probable that but for one circumstance connected with the climatic conditions of the Cœur d'Alene forest areas there would long since have been felt a very severe scarcity of water in the summer season throughout the regions where fires have exterminated any considerable portions of the growing timber. The feature referred to is the absence of frosts in the ground during the winter months—a condition which prevails even at elevations above 2,400 meters (7,900 feet). Owing to this the lower surface of the snow melts slowly all winter, and the weight of the heavy superincumbent mass pressing down firmly on the soil holds back the water and compels its absorption.

Manifold other evils arise from the destruction of the forests. There are the snow slides that imperil life and property with every recurring spring; avalanches of rock and dirt that are loosened and slide down the steep hillsides to the bottoms of the valleys; inundations in the mountain regions and along the courses of the rivers through the plains; sand, gravel, and bowlders washed down the valleys and spread out over the fields; new and wider stream channels, cut by the spring torrents, which in narrow valleys with much alluvium becomes a serious matter, especially along the portions of the streams which meander through the plains, and pretty certainly a lessened amount of rainfall over the plains area. It is a matter of popular experience that the longer the snow remains on the mountains the more abundant and copious are the spring and summer showers on the open and timberless regions.

The following clipping from the Spokesman-Review, a newspaper published at Spokane, Wash., is so pertinent to the subject of the water supply of the Cœur d'Alenes as affected by the destruction of the forests that it is here appended, with the necessary comment for a proper understanding of the same:

> The water problem is a serious one in the Cœur d'Alenes at present. The mills depending upon a water supply have in many cases been compelled to close down. A number of reservoirs are being built this fall, and this will greatly augment the supply.
>
> The lack of water is seriously interfering with the working of the Hunter mill. As a consequence, 50 men were laid off last week, as the stopes and chutes were full of ore and the mill could not keep pace with the mine.

The mills to which these paragraphs refer are concentrating plants, and are situated partly in Canyon Creek, a tributary of the South Fork, and partly in the upper portion of the valley of the South Fork. They are nearly in the central areas of the great burns that have spread from the Mullan road and from the placer fields in the southeastern parts of the North Fork basin. The streams they utilize head and have their tributaries almost wholly in and from mountain slopes on which the destruction of the forest varies from 80 per cent to total. Each of the streams carries a very much greater volume of water in the spring now than was the case in the past. This is shown conclusively by the cutting of the channels, the height of the lodged driftwood, and the greater amount of sand, gravel, and rock washed down to lower levels each spring. Even were there present none of these physical signs, a moment's reflection would convince us that such must be the case. The hills, once forested, are now bare; the winter's accumulation of snow, unprotected from the direct rays of the sun, melts rapidly in the spring; the rain and snow water, not now held back by the deep humus and the other multitudinous obstacles which were there when the forest covered the slopes, runs off swiftly. In the summer the evaporation is enormously increased from the denuded areas. A scarcity of water during a portion of the year is the inevitable result. Recourse will now be had to the reservoir system, with a fair prospect of much trouble in controlling the spring floods. The Hunter property, referred to above, is the most easterly of the concentrating works in the South Fork valley, and as a consequence has the least amount of available water from this stream.

A NEW SYSTEM OF TIMBER PROTECTION.

It is not my purpose to attempt here a review of the various acts and laws which have been framed during the last two decades for the purpose of regulating the sale and protection of the timber on the forested areas of the western United States. That the timber laws now in force are evaded, circumvented, or absolutely ignored is a patent fact. Two means are depended on chiefly to prevent the deforesting of the public lands on the Pacific Slope; they are the detection of timber trespassers by a corps of special agents acting under the authority of the Department of the Interior and the reserving of certain tracts against entry—the so-called timber reserve.

The detection and punishment of trespassers upon the public forest domain by the system of special agents is totally inadequate in practice, however good the intention of the framers and executors of the law. It is impossible for any one individual to patrol even a limited district in regions so difficult as are most of the Western ranges, and when timber trespassers are apprehended a conviction is by no means certain, for the weight of popular opinion is almost invariably on the side of the accused.

By establishing forest reserves we may be able to control all logging operations on the areas covered by the reserve. We, however, can not prevent fires from outside spreading beyond the boundaries. In a single season they may deforest a much larger tract than logging or lumbering operations would have done in several decades. The single factor of forest fires demonstrates amply that a timber reserve only protects against one class of timber depredators, who stand far from the head of the list.

That none of the present arrangements for protecting the forests are even moderately successful is a fact painfully evident to every observer. There are so many loopholes and the acts and regulations, dating back through many years, are so diverse that some plan can nearly always be contrived for trespassing without punishment upon the public timber lands.

The most common and the simplest method is that of the squatter. The portable sawmill is set up, first here and then there; with it follows a crew of employees and professional squatters. Land in the vicinity of the mill is covered by squatters' rights, a slight pretense is made at agriculture, the valuable timber is cut off and converted into lumber, and the concern moves on. Or the programme is varied by the squatter going into some mountain valley along a stream where logs can be floated to market. As before, a claim is staked off, notices posted announcing that the claim is taken under such and such an act, a mere pretense at improvement is made, often in a region where it would be impossible to carry on agricultural operations of any kind, the logs are cut and floated, and the claim is abandoned. Perhaps a number of these trespassers are apprehended; but it is one thing to apprehend and another to convict.

The railroads act indirectly as trespassers through their tie and fuel contractors. Little regard is paid by the latter to public ownership of land. The contractor cuts his ties where the timber is the choicest.

The miner becomes a depredator under various pretexts. An old ruling or law which permits him to cut timber from the public domain for mining purposes is interpreted with the utmost latitude. If the miner happens to be a mine owner as well, his views as to his rights under this old law are extremely elastic.

The farmer living in the timber becomes a trespasser by cutting fuel on the public lands and disposing of it. Sometimes he squats on a piece of land from which the timber fit for lumbering purposes has already been removed. When all that is readily converted into fuel is gone, he goes too. That a farmer living upon forest-covered lands entered under the homestead laws can not legally sell the timber from such lands until patented to him is a matter which is not generally known.

In the case of Shiver *v.* U. S., 159 U. S. R., 491, the United States Supreme Court decided, in an opinion handed down by Justice Brown, that lands entered under the homestead laws are not by the mere act of entry so segregated from the public domain as to give the homesteader a right to sell timber from his entry. The decision is in part as follows:

> Where a citizen of the United States has made an entry upon the public lands of the United States under and in accordance with the homestead laws of the United States, which entry is in all respects regular, he may cut such timber as is necessary to clear the land for cultivation, or to build him a house, outbuildings, and fences, and perhaps may exchange such timber for lumber to be devoted to the same purposes; but he can not sell the timber for money, except so far as it may have been cut for the purpose of cultivation; and in case he exceeds his rights in this respect, he may be held liable in a criminal prosecution under section 2461 or section 5388 of the Revised Statutes of the United States, or either of said sections, for cutting and removing, after such homestead entry, and while the same is in full force, the standing trees and timber found and being on the land so entered as a homestead.

A vigorous application of this decision would have a twofold result. It would very materially diminish the number of farms taken up in the heavy forest and the fires that spread from the efforts of the settlers to clear up the land. While it is fairly well known that a squatter can not legally remove the growing timber on the land he occupies for purposes of sale, it is not at all understood and believed that this provision applies to land upon which a homestead filing has been accepted at the local United States land office. A great many with limited means settle on forest lands expecting to be able to dispose of fuel and timber from their claim in sufficient quantities to enable them to tide over the time that must pass before it can be made fit for tillage. While the enforcement of this decision will work hardships to many individuals, it can not but be to the advantage of the public at large eventually, inasmuch as it takes away a great incentive to settling on forest lands and in so much assists in preserving the timbered areas.

The method of special agents, which is relied upon to detect trespassers and keep the evils of forest depredations in check, is held in utmost contempt by those who are guilty of infringing the timber laws or contemplate doing so. Not only is the system despised, but the men who work under it as well; for, right or wrong, in the minds of the people of the West there is a firm conviction that a true charge of venality would lie in connection with any of these offices.

We have seen that the forests of the West stand in need of protection, and that if this is not afforded their entire destruction is merely a matter of a comparatively short time. It is not sufficient that a tract be set aside here and there as a forest reserve. A wider application of a protective system is needed. It should cover alike all areas of the public timber lands in their uttermost extensions, even those which now are simply burned and blackened tracts and those which, situated on remote mountain slopes, are at present too difficult of access to be utilized.

Below is presented the outlines of a plan entirely feasible and practical, that will furnish a substantial foundation for the erection of a system which, if properly and faithfully carried out, can not fail to prevent the depredations that now lay waste the forests. It will not only protect the tracts now belonging to the public domain, but also, to some extent, those which have already passed outside the immediate ownership of the General Government.

The plan to be proposed may be called the resident district commissioner system. The primary feature of this plan is the division of all the forest areas throughout the Western States where the Government still controls the major portion into districts with definite boundaries and the absolute prohibition within these limits of removing or converting to any private use timber, growing or dead, without the issuance of a license by the official in charge of such district.

The supervision of each district should be confided to a resident district commissioner, who should act under the immediate direction of a general commission or commissioner of forestry. The district commissioner should reside at some generally accessible point within his district and should be a bonded officer. His jurisdiction should extend to all cases arising within the district except certain ones hereinafter specified, which should be referred to the general forestry commissioner for his action, with the necessary information and the district commissioner's recommendation appended.

To enable the district commissioner to exercise a perfect control over all portions of the tract within his jurisdiction a comprehensive system of licenses should be made effective. It should cover all cases of every nature where the removal of the timber from the public domain is concerned. The district commissioner should issue licenses to all applicants, except as hereinafter specified, and should keep accurate copies and files. Monthly reports setting forth the particulars, with copy of each license issued, should be made to the general commissioner of forestry, who would thereby be enabled to judge as to the actual amount of timber removed from each district monthly.

Let us examine in detail the different classes and purposes to whom and for which licenses should issue, beginning with the prospector for mineral deposits. This class of timber depredators is by far the most difficult to control. They are very numerous, and each summer they scatter over a great area of country, very often the most difficult of access, where it is impossible to subject them to direct supervision even were the forest areas patrolled.

To fit their case the mining laws should be so amended as to require each one of them to secure a yearly license before being allowed to prospect for mineral lodes upon any part of the public domain. These licenses should hold good in any locality for the time issued (one year), but before any prospector could legally enter within the boundaries of a district different from the one in which his original license was issued for the purposes of discovering mineral deposits he should be required to have his license duly indorsed by the commissioner for that district. There should be as an aid a law framed defining the act of firing the public forest domain as a crime, and fixing punishments both by fine and imprisonment, with a reward for the detection of the criminal. Copies of this law should be supplied to every prospector applying for a license. The system of licensing the prospectors would result in keeping an accurate tally of all persons in a district employed in this work. I am of the opinion that the knowledge of this fact, together with the certainty of severe punishment if detected, would very materially reduce the number of forest fires due to this cause if it did not entirely prevent them.

Wood choppers, tie choppers, charcoal burners, sawmill and logging concerns should be required to obtain yearly licenses upon their applications, setting forth where they intend to operate, for what purposes, and the estimated value of the yearly product. If this exceeded a certain sum, say $1,000, the application should be referred to the general forestry commissioner, with the facts of the case as indorsed by the district commissioner. If the yearly output was less than $1,000 in value, the authority of the district commissioner to issue the license should be sufficient. A stumpage should be charged in connection with the removal of any portion of the timber for purposes of profit. Each of these licensed occupations should be required to file monthly or quarterly with the district commissioner sworn statements as to the quantity of timber taken, and upon the basis of this the stumpage should be collected, penalties being provided for false returns, and the scaling books of logging and lumbering concerns to be open for inspection by the commissioner at any time, as also the accounts of tie and wood choppers. When the value of the yearly cut by any lumbering concern exceeded a certain amount, say $1,000, a bond in a sum sufficiently large to cover the value of the product above this sum should be exacted. Miners should be placed upon the same footing as the foregoing classes. The law or ruling which permits them to fell timber on the public domain for mining purposes should be repealed. As it now stands, mining companies take timber not only adjacent to their claims, but miles away when it happens to be easier of access or choicer in quality. There should be no exception. The timber standing on an unpatented mining claim should require a license for its removal just as much as though it were miles away. This should also apply to mill sites located in connection with lode claims. The licenses issued to any of the foregoing classes should be valid only in the district where issued. The law permitting parties to buy timber lands valuable chiefly for their timber and stone and unfit for agricultural purposes ought to be repealed. It is now to a great extent a cloak made use of by the big lumber concerns in the regions where it applies to acquire cheap timber lands for their sawmill operations. Private ownership of forest lands is a certain way to destroy the timber. The owners rarely look for anything beyond some way to make it profitable as quickly as possible. The conservation of the forest upon any such tract is never considered.

A strong and persistent effort should be made to discourage agricultural settlements in the heavy forest region. The value of the product on many tracts of agricultural lands won from the forest will not equal the value of the timber the tract could produce. More attention should be directed to the capabilities of the arid regions, where the same amount of labor bestowed upon irrigation as is now wasted in clearing the heavy forest would result in far larger returns than can ever be had from any tracts in the frosty mountain regions. No one should be permitted to settle upon lands covered with a forest which requires to be cleared away to fit it for agriculture without first submitting an application to the district commissioner, who should examine the tract in question, and if, in his opinion, the land was more valuable for agricultural purposes than for its timber he should so indorse it upon the application; and no filing at any land office upon lands covered with a forest should be accepted unless indorsed in the affirmative by the district commissioner.

No person living upon unpatented lands, agricultural or other, should be permitted to burn for clearing or remove for sale any timber growing on the claim without a permit from the district commissioner.

Parties desiring to open roads or trails through the forest which would involve the cutting of timber should be required to make written applications to the commissioner, setting forth the point of beginning and ending and for what purpose.

Railroad companies operating lines which traverse the forest areas should be compelled to provide thoroughly efficient spark arresters for the smokestacks of their locomotives, or, failing to do this, the right of way through the forest should be kept permanently clear of all débris that would enable a fire originating on their premises to spread into the adjoining timber, and the cost of such work, if done by the district commissioner, should be a lien upon the property of the company until paid.

It is customary around many saw and shingle mills since the law prohibiting the throwing of sawdust into streams became effective to burn the refuse. This is sometimes carried away to a distance from the mill and there consumed. Fires occasionally spread from such places into the forest. Regulations should be made effective that would obviate all danger from this source.

Any person to whom the foregoing provisions of licenses apply, if found pursuing his avocation in the forest regions without the proper permits, should be treated as a trespasser and punished as such. Simple ejectment as a penalty would be insufficient. Fine or imprisonment, or both, should be imposed, and in the case of prospectors no mineral-claim location should be recorded unless the discoverer possessed the proper license.

Around many of the larger mining camps in the forest areas are found a class of squatters holding small parcels of land outside the town limits. They are mostly miners by occupation, live there with their families, and cultivate small patches of land for gardens. As these holdings are within the areas where the land would be considered more valuable for forest purposes than for agriculture, no filings upon these lands, unindorsed by the commissioner, should be accepted at the land office. A provision should be made for this class by permitting the occupancy of small tracts within the forest limits—say 10 or 15 acres—at the discretion of the commissioner, the title to be merely possessory, but to be transferable to other parties in the manner of a mining claim, with this exception, that no patent from the United States should ever issue for the same to anybody, it being only regarded as a lease from the United States to the party actually in occupancy.

In dividing the forest areas it would be best to follow political boundaries for the present, as, for example, county lines, although by such a plan many districts would include considerable areas destitute of forests. To limit the districts to the tracts actually covered by timber would be preferable, but would require much time and cost.

The system would be to a great extent, if not wholly, self-supporting. In addition to the stumpage income a certain fee should be required for each license. In addition to this the mining laws should be so amended as to require all filings upon mineral claims to be made with the district commissioner instead of the county clerk, as is now the case. This would in the mining districts add to the revenues and serve as an additional check upon the prospectors. Deputy district commissioners should be permissible where necessary, as should also district mining recorders for the convenience of miners in remote places.

That a system of this sort could not be put in force without encountering a great deal of opposition may be taken for granted at the outset. Its application would so materially circumscribe the freedom now enjoyed by the various classes of timber depredators that strong efforts to frustrate any plan that aimed at curtailing it would certainly be made. However, it is reasonably sure that the majority of the people would cheerfully obey such a system. It would extend the protection of the Government to all classes engaged in timber production, and enable them to pursue their vocations unmolested. Timber and fuel are needed to develop the West. The people must have them. For want of a proper system of licenses easily obtained they resort to all manner of trespasses. The system of timber reserves, even with the bill presented last winter permitting the sale of timber at the discretion of the Secretary of the Interior, does not and would not protect sufficiently, and renders the purchase of timber by the smaller concerns a very difficult matter. Whatever plan or system may be finally adopted, let this be taken as an assured fact, that the strong hand of the General Government, without delay, fear, or favor, is urgently needed to put in effective force regulations that shall thoroughly protect the forests of the West and restrain the waste that now runs rampant throughout their entire extent.

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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

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NOTES ON THE PLANTS USED BY THE KLAMATH INDIANS OF OREGON.

BY

FREDERICK V. COVILLE.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., April 14, 1897.

SIR: I have the honor to transmit herewith, for publication as one of the Contributions from the United States National Herbarium, a manuscript entitled, Notes on the Plants Used by the Klamath Indians of Oregon.

As opportunity has offered, the members of our botanical staff, when working in the field, have recorded all the reliable information they could secure on the uses of native plants by the American aborigines. In the present series of notes are included a few plants which give suggestions of usefulness in our own arts and industries. Among these may be mentioned the yellow pine-lichen, which produces a beautiful canary-yellow dye; the Rocky Mountain flax, which furnishes a strong, fine fiber; and several of the tuberous-rooted perennials of the parsley family, which make palatable and nutritious foods. The fact on the one hand that such native American plants as Indian corn, the potato, canaigre, cascara sagrada, istle, and many others have already become established articles of trade; and the fact, on the other hand, that we are constantly striving to find agricultural products suited to our subarid regions, make very pertinent the question whether we shall not make a serious attempt to domesticate additional species of our native plants which are known to withstand a dry climate perfectly.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

Page.
Lichenes 87
Equisetaceae 88
Pinaceae 88
Taxaceae 89
Typhaceae 90
Sparganiaceae 90
Scheuchzeriaceae 90
Alismaceae 90
Poaceae 91
Cyperaceae 92
Juncaceae 92
Liliaceae 93
Iridaceae 93
Salicaceae 94
Betulaceae 94
Fagaceae 94
Urticaceae 95
Polygonaceae 95
Chenopodiaceae 95
Amarantaceae 96
Nymphaeaceae 96
Berberidaceae 96
Brassicaceae 96
Saxifragaceae 97
Rosaceae 97
Linaceae 99
Rhamnaceae 100
Loasaceae 100
Onagraceae 100
Apiaceae 101
Ericaceae 102
Apocynaceae 103
Polemoniaceae 103
Nepetaceae 104
Scrophulariaceae 104
Viburnaceae 104
Valerianaceae 104
Carduaceae 105

NOTES ON THE PLANTS USED BY THE KLAMATH INDIANS OF OREGON.

By Frederick V. Coville.

While engaged in a botanical survey of the plains of southeastern Oregon in the summer of 1896 the writer spent three days, August 21 to 23, at Fort Klamath and the Klamath Indian Agency, where he was enabled to secure information as to the principal plants used by the Klamath Indians. The notes made at the time are here brought together for publication, with a view to their use by others in securing fuller and more detailed data about the aboriginal uses of plants by this tribe. The writer hopes, when the necessary material has been collected, to prepare a comprehensive paper on the subject.

Most of the information here recorded was obtained from Joe Kirk, an educated Klamath Indian, who for several years has been the official interpreter at the agency,. and from White Cindy, a Klamath medicine woman who lived on a small ranch on the lake shore a few miles south of the agency. Capt. O. C. Applegate, of Klamath Falls; Mr. Charles E. Worden, the allotting agent for the Klamath Indians, and Jesse Kirk, the brother of Joe Kirk, gave additional information.

The diacritic marks used to indicate the pronunciation of the Indian names are those employed in the Century Dictionary.

LICHENES.

Alectoria fremontii Tuckerm.

A lichen consisting of slender black threads hanging in masses often a foot in length from the branches of trees in the pine forests, particularly abundant on the black or lodge-pole pine, *Pinus murrayana*. The plant was sometimes used in former years as a famine food. To the present white inhabitants of the region it is commonly known as "black moss."

Evernia vulpina (L.) Ach.

Shwä'-wi-säm.—A bright yellow lichen, often called "yellow moss," which grows in abundance on the trunks of yellow pine and other trees. Porcupine quills obtained from the Modocs are immersed in a decoction of this lichen and take on a beautiful bright yellow permanent stain. These quills are then interwoven into baskets to form any yellow pattern desired.

EQUISETACEAE.

Equisetum hyemale L.

Wä-chäk'-wis.—One of the common jointed scouring rushes. This was formerly used to smooth arrow shafts, just as a carpenter uses sandpaper to smooth the surface of wood.

PINACEAE.

Abies concolor (Gord.) Lindl.

Bä.—The white fir of the region, a tree occurring more or less abundantly throughout the yellow-pine forest. The wood of the tree is called bä'-näm. The bark is sometimes used to dye and tan buckskin, giving it somewhat the appearance of ordinary tan-colored leather.

Juniperus occidentalis Hook.

The common red cedar of the region, often made into bows for boys, rarely in former days into those used by men, the yew being much superior.

Libocedrus decurrens Torr.

Wöl'-wänsh.—The "cedar" of the region, a large tree occurring sparingly, or in particular places abundantly, throughout the yellow-pine forests. The wood of this tree (wöl-wän'-shäm) was used in former times for fire blocks. My informant stated positively that the bark of the tree, which some authors say is used for this purpose, is not the part employed. For a twirling stick a dry, dead twig of yellow pine, about 6 mm. (one-fourth inch) in diameter, seasoned and somewhat softened by the weather, is often employed; but the best stick is made of sagebrush, *Artemisia tridentata.*

At one of the Indian houses was seen a large V-shaped pack basket, woven from strands of light, flexible wood, which apparently had been split from large pieces of *Libocedrus decurrens.*

The branches and twigs of this tree are often used in administering a sweat bath to a sick person.

Pinus lambertiana Dougl.

Ktä'-lö.—The great sugar pine, occurring in greater or less abundance in the yellow-pine forests, particularly at their higher elevations. The seeds are sometimes gathered for food.

Pinus murrayana Balf.

Wä'-kō.—The lodge-pole pine, also called black pine and tamarack pine, an abundant tree in the low and moist portions of the yellow-pine forests. Sections of bark from trunks of the proper size are often used to make buckets for gathering berries, particularly huckleberries. The cylinder of bark is sewed together on the slitted side and at one end, the bottom therefore being wedge-shaped. Huckleberries when placed in such receptacles and properly covered with large leaves retain their freshness for a long time.

The pitch of this tree is sometimes used as a remedy for sore eyes, a very small fragment being placed inside the lid.

The trunks of young lodge-pole pines stripped of their bark are used for the poles with which dugouts are pushed through shallow water.

I was informed by Capt. O. C. Applegate that in April the cambium layer of this tree is scraped off and eaten, either as a relish or in time of famine, in exactly the same manner as the inner bark of the yellow pine.

Pinus ponderosa Dougl.

Nkōs.—The yellow pine, the most abundant forest tree of the region, which furnishes the Klamaths with their chief timber. Their boats, called dugouts, are made from single logs of yellow pine, hollowed out by fire carefully manipulated. Most of the sawed lumber now used by the Indians in the construction of their modern houses is of yellow pine. For the use of yellow-pine twigs as twirling sticks in producing fire by friction, see *Libocedrus decurrens.*

Käp'-kä is the name applied to a young tree of the yellow pine. In the spring, usually in the month of May, a broad strip of the bark is removed, and the sweet mucilaginous layer of newly forming tissue (stop'-älch) between the bark and the sap wood is scraped off and eaten. This is seldom practiced now, but in former years it must have been done commonly, for in the forest between the Chiloquin and Yainax bridges many old trees were seen whose trunks bore great scars, perhaps a meter in height and one-third or one-half as broad, where the bark had been removed when the tree was young.

TAXACEAE.

Taxus brevifolia Nutt.

Tsö-pink'-shäm.—The yew tree, an evergreen, with leaves similar to those of a hemlock or spruce, and red berries. Abundant on the western slope of the Cascades, occurring on the eastern slope in Union Creek and on Pelican Bay, Klamath Lake. It furnished the favorite wood for bows before the adoption of firearms. These yew bows may still be seen occasionally among the Klamaths, but apparently they are kept only as relics, not for actual use. They are commonly about a meter in length, backed with sinew, the tips covered with fishskin and the string made of twisted sinew.

TYPHACEAE.

Typha latifolia L.

Pō′-päs.—The common cat-tail or cat-tail flag, abundant about Klamath Lake, Klamath Marsh, and marshy places generally. The short tuberous rootstocks late in the season, when full of stored food, are eaten under the name of ktōks; the leaves are used in the manufacture of mats very much after the manner of Carex; and the down of the fruiting spikes has been employed in recent times as a stuffing material for pillows.

SPARGANIACEAE.

Sparganium eurycarpum Engelm.

Pöd′-chäk.—The bur-reed, a marsh perennial, commonly a meter in height, with flat leaves somewhat resembling those of a cat-tail but of a bright green color, the fruit borne in spherical bur-like heads. It is common about Klamath Lake, and doubtless in other similar situations. The young rootstocks late in summer develop at their ends tubers which have a sweetish taste and are used for food. The bulbous expansion at the base of the stem, similar in its qualities, is likewise eaten, and is called klop′-ä.

SCHEUCHZERIACEAE.

Triglochin maritima L.

Gil-lĕn′-ä.—A rush-like perennial, of usually alkaline marshes, with numerous slender thickened basal leaves and a long naked flowering stem bearing a spike of greenish flowers, each succeeded by six seed-like carpels. These are parched and eaten, and sometimes, according to one Indian woman, roasted and used as a substitute for coffee.

ALISMACEAE.

Sagittaria arifolia Nutt.

Chö-ä′.—Arrowhead or wappatoo, a marsh plant, with large tender leaves shaped like arrowheads, and white flowers, common in permanently muddy soil everywhere. In autumn the slender rootstocks develop at their ends white tubers filled with starch and very nutritious. The Chinook name for the plant, wappatoo, which is widely used in the Northwest for this and another species, *Sagittaria latifolia* Willd., is a good popular designation.

From the fact that the tubers bear a general resemblance to those of the cultivated potato the name chö-ä′ was at once applied to that plant when it first became known to the Klamaths. The name *Chewaucan*, applied to a great marsh in the Oregon plains east of the Klamath Reservation, was derived from this word, with the addition of the suffix *can*, a place, the whole meaning the place where the arrowhead grows. Frémont, passing across Chewaucan Marsh, December 19, 1843, wrote on page 208 of his report:

> Large patches of ground had been torn up by the squaws in digging for roots, as if a farmer had been preparing the land for grain.

POACEAE.

Agrostis perennans (Walt.) Tuckerm.

Nō′-tăk.—A small low grass, with a loose airy panicle, of common occurrence about Klamath Agency. The minute seeds are gathered for food. Though no specimens were collected, the plant is probably referable to this species, which is known to occur in the region.

Beckmannia erucaeformis (L.) Host.

Chăp′-tö.—Slew-grass, a perennial species, often a meter in height, the inflorescence a narrow panicle with spike-like branches. The species is of frequent occurrence in natural meadows and on the borders of summer pools. Its seeds are sometimes used for food.

Elymus condensatus Presl.

Gla′-i pi.—A tall grass, 1 to 2 meters (about 3 to 6 feet) in height, growing in bunches along river bottoms and locally known as "rye grass." The large grains were formerly and still are to some extent used for food under the name gla′-i-pi-äm″.

The size of the grains and the fact that this grass, the grain-filled heads of which are one of the most nutritious winter horse foods, covers countless acres along streams in the plains, suggests that it may be worthy of experimentation as a cultivated grain for that region.

Panicularia fluitans (L.) Kuntze.

Kăm′-chö-dă″-lis.—A stout marsh grass, often called "sugar grass," about a meter in height, with short, broad leaves, commonly 25 cm. by 1.5 cm. (about 1 foot by three-fifths of an inch), and bearing a spreading panicle of small flower spikes. It is common in all the marsh lands. The seeds are a favorite article of food among the Klamaths.

Phragmites phragmites (L.) Karst.

Tsăl, or *shăl.*—The common reed, in this part of the country known usually as "cane grass," a tall marsh plant, higher than a man, bearing a large plume of feathery flowers. Selected strands peeled from the surface of the stem and split till they have a width of commonly 2 to 3 mm. (one-twelfth to one-eighth of an inch) are used in the surface finish of some of the finer baskets. These strands are of a pale straw color, smooth and shining, and are known by the name tkōp.

The seeds of Phragmites are sometimes used for food.

The stems are used to make arrow shafts for hunting small game, such as waterfowl. The rod-like tips of such arrows are made of currant wood, probably *Ribes cereum.*

CYPERACEAE.

Carex sp.

Bha′-nē.—A tall sedge or marsh grass with pubescence on the base of the leaves and the upper part of the leaf sheaths, abundant along the muddy margins of Klamath Lake, on the shoreward side of the tules. The long, tough, but rather light and buoyant, leaves are woven into mats, commonly 1 to 2 cm. thick (about two-fifths to four-fifths of an inch). The mats consist of small parallel bundles of the leaves fastened together at intervals by interlaced strands of some strong textile material, commonly in old times the Rocky Mountain flax, *Linum lewisii.* The plant was not seen in flower or fruit, but it is probably a Carex.

Carex sp.

Wich′-pī.—A tall, coarse sedge, common about the margins of Klamath Lake, in shallow water. It was not seen in flower or fruit, but probably belongs to the genus Carex. In early summer the growing stems, stripped of leaves and peeled, are used fresh for food, the white pith-like tissue being filled with a very palatable sugary juice. The tuberous base of the stem is also used for food under the name khä-äls′.

Scirpus lacustris occidentalis Wats.

Mä′-i.—The common tule of marshes and lake borders, abundant in the Klamath country. The stems are commonly used in the construction of mats after the manner of bha′-nē, *Carex* sp. In the making of certain closely woven baskets, especially the small ones used as hats, thin strips from the surface of a tule stem, twisted, doubled, and twisted again, are used, under the name of twäch, for the uprights. Mōk′-wäs is the name used for the stained tule strands of which the black figures in these baskets are made. The color is obtained by immersing selected stems of tule in the black mud which surrounds the sulphur springs of the region. The yellow patterns are made with porcupine quills, smī′-äm, dyed with a yellow lichen, *Evernia vulpina*, which see.

The seeds of tule, mä′-ēm lä′-wäls, are sometimes used for food,

JUNCACEAE.

Juncus balticus Willd.

Tsin-ä′-ō.—The commonest rush of the region, growing on sandy shores, especially in alkaline soils, and everywhere known as wire grass. The tough green stems are sometimes used in the weaving of mats and light baskets, and the Indians often weave from them small spoons for temporary use.

LILIACEAE.

Calochortus macrocarpus Dougl.

Yänch.—A plant described as similar to camas—that is, in its bulb, doubtless—and like it an article of food. A boy was sent out into the sagebrush to get some, but on account of the lateness of the season, the last week in August, he could find none of the tops. From the description of the plant, however, it is probably *Calochortus macrocarpus.* It bears from 1 to 6 large, tulip-like, white or pale-purple flowers.

Quamasia quamash (Pursh) Coville.

Pâks.—The well-known camas, a liliaceous plant with a raceme of blue flowers, narrow almost grass-like leaves, and a bulb resembling that of a tulip. It is common in the open meadows of the yellow-pine forests, and from its extreme abundance gives to them the popular designation "camas meadows." The bulbs are gathered in spring, about the 1st of April, and either stored, without preparation, for future use, or steamed in pits after the manner of *Valeriana edulis.*

Capt. O. C. Applegate informed me that in the Willamette Valley before the days of cultivated fruits the early settlers' wives used camas bulbs in making pies. The camas of that region is probably *Quamasia leichtlinii* (Baker) Coville.

In gathering camas, a pointed instrument, in the old days usually made of the wood of mountain mahogany, *Cercocarpus ledifolius*, is thrust into the ground and the bulbs pried out. A modern camas stick, manufactured by an Indian blacksmith, was made of a bar of three-fourths inch steel 76 cm. (30 inches) long, with a crossbar at the top 12.7 cm. (5 inches) long, the lowermost 10 cm. or more tapering to a sharp point, and bent forward about the diameter of the bar.

Zygadenus venenosus Wats.

Scä'-ō, or *scou.*—A plant popularly, and doubtless correctly, supposed to poison cattle; well known locally under the name "poison camas," "white camas," and "lobelia," and common in the natural meadows. The roots when eaten cause extreme vomiting. See under *Iris.*

IRIDACEAE.

Iris missouriensis Nutt.

Ghä'-gum läk'-ō.—The blue flag or Iris of the region, common in moist meadows, especially those in which the soil becomes dry later in the season. The dried rootstocks are sometimes used by medicine men as a smoking material, mixed with white camas, *Zygadenus venenosus*, and a little tobacco, to give a person a severe nausea, in order to secure a heavy fee for making him well again.

SALICACEAE.

Populus balsamifera L.

Kō-osh'.—The so-called "cottonwood" of the region, properly known as the balm of gilead poplar. A long time ago the bark of this tree, when peeled and split, was used in the manufacture of an Indian cloth.

Populus tremuloïdes Michx.

Vö'-läl.—The aspen, more commonly known in the region as quaking asp. In former times its bark was peeled off and used to make hats.

Salix sp.

Yäs.—A general name for willow, several species of which occur on the Klamath Reservation. The frames of snowshoes are usually made of willow wood. The mesh in old times was commonly made of the Rocky Mountain flax, *Linum lewisii*, less commonly of nettle fiber, *Urtica breweri*.

The young shoots of willow, called yä'-yäk, usually stripped of their bark, are commonly used as a material for pack baskets.

BETULACEAE.

Alnus tenuifolia Nutt.

Wip'-läm.—The characteristic alder of the region, common along streams and the margins of bodies of fresh water. The bark is taken from the tree in the spring by peeling, at other seasons by whittling, and in either a fresh or dry state is boiled in water for use as a dye. The color, described as a bright reddish yellow, is doubtless orange, and before the advent of the dyes of civilization was in common use in coloring horsehair ropes, cinches, etc. Along the stream at old Fort Klamath in the latter part of August, 1896, I saw an alder tree which had been stripped of its bark only a few days previously, doubtless by one of the Indian women who live in the vicinity.

FAGACEAE.

Castanopsis chrysophylla minor (Hook.) A. DC.

The so-called chinquapin of the region, a shrub of the higher mountains, seldom more than a meter in height and often forming dense thickets, its nuts borne in burs similar to those of the chestnut, but smaller. The nuts are sometimes gathered by the Indians for food.

Corylus californica (DC.) Rose.

The hazelnut of the Northwest Coast. The nuts of this plant, which in the form of a small shrub penetrates the Cascades from the west through the valley of Klamath River as far as Pelican Bay, on Klamath Lake, are occasionally used for food by the Indians.

URTICACEAE.

Urtica breweri Wats.

Sleds.—The native species of nettle, a tall perennial with opposite leaves and four-angled stems, provided with stinging hairs. The fiber of the stems is used in the manufacture of cords and nets. See also under *Salix.*

POLYGONACEAE.

Eriogonum stellatum Benth.

Ba-băk''-bak-lha'-năm.—A low shrub, the small, rounded, cottony leaves of which, about 2 mm. (four-fifths of an inch) in diameter, are placed on burns to soothe the pain by protecting the surface from the air.

Eriogonum elatum Dougl.

Kă'-a-lum-kēs.—The plant is not used, nor was the significance of the name discovered.

Polygonum douglasii Greene.

Kăp'-i-önks.—A slender, usually much-branched plant about 50 cm. (approximately 1½ feet) high, with black, shining seeds shaped like those of buckwheat, but smaller, and narrow sheathing leaves. At maturity the seeds are inclosed in the dry, papery calyx or "hull," and in this condition they are gathered. The hulls are rubbed off by hand, and the seeds parched and often ground. This meal is either eaten dry or mixed with water and boiled, a process which turns the material red. No growing specimens were seen by the writer, but the seeds secured were from a lot gathered in dry, sandy soil on the east side of Klamath Marsh, where the plant is abundant.

Rumex geyeri (Meisn.) Trelease.

Ken-ă'-wăt.—This is a plant of which the leaves and stems are eaten fresh, and the seeds, which are "flat like those of a parsnip," are eaten when ripe. From the description given by the Indians the plant may belong to this species.

Rumex salicifolius Weinm.

Gō'-klaks.—One of the native species of dock, common in low, open, somewhat alkaline soils. The seeds are used for food. My informant stated that there were three kinds of this plant, from his description apparently all belonging to the genus Rumex, each with a different Indian name, and also used for food.

CHENOPODIACEAE.

Chenopodium fremonti Wats.

Kōts-on'-iks.—The native goosefoot or lamb's quarters of the region, a common annual weed in cultivated fields. The minute, black, lens-shaped, shining seeds are gathered at maturity, in late summer, and after the customary roasting and grinding are used for food. It is of interest to note that a species of the same genus, *Chenopodium quinoa*, has for centuries constituted the chief farinaceous food of the inhabitants of the high plateau of Bolivia and Peru and has now become a cultivated plant.

AMARANTACEAE.

Amarantus blitoides Wats.

Bä-lō'-ōch.—A small amaranth, probably of this species, occurring as a weed in cultivated grounds or waste places. The black shining lens-shaped seeds, about 1 mm. (one twenty-fifth of an inch) in diameter, are sometimes used for food.

NYMPHAEACEAE.

Nymphaea polysepala (Engelm.) Greene.

Wō'-käs.—The great yellow water lily, occurring at Wocus Bay and a few other places on Klamath Lake, and in endless amount in Klamath Marsh. The large mucilaginous seed pods are gathered in boats, the seeds extracted after some process of drying the pods, and then stored for use during the year. The common method of preparing the seeds for use is to roast them either in an open basket with live coals, or more commonly in recent years in an iron frying pan over a fire. When treated thus the seeds swell and crack their coats much after the manner of parched corn. The roasted seeds are commonly eaten dry without further preparation, tasting very much like popcorn, but sometimes they are ground into meal and made into a porridge or a bread.

This is probably the most important farinaceous food of the Klamaths. They gather enormous quantities of it during the months of July and August, nearly all the old women of the tribe going to the marsh for the purpose. It is such a favorite food with the tribe that its use is likely never to be wholly given up.

BERBERIDACEAE.

Berberis repens Lindl.

Bä-bä'-ö-säm.—The most widely distributed species of Oregon grape, a small, low shrub of the yellow-pine forests, seldom more than 15 cm. (6 inches) high, with holly-like evergreen leaves and clusters of small, grape-like, sour, blue berries, these known by the name gä'-ö gä'-ö-säm. The berry is said not to be eaten by the Klamaths, nor could I learn of any use, medicinal or other, to which the plant is put.

BRASSICACEAE.

Sisymbrium incisum Engelm.

Chĕp'-äs.—A slender, branching annual, commonly 25 to 50 cm. (10 to 20 inches) high, with pinnatifid, canescent leaves, yellow flowers, and slender racemes of narrow, divergent pods. It occurs in open, upland soils, often as a weed in cultivated fields. The seeds, called chēp′-säm, are parched and ground for food.

SAXIFRAGACEAE.

Philadelphus lewisii Pursh.

A shrub with white or cream-colored sweet-scented flowers about 2.5 cm. (1 inch) in diameter. The stems of this shrub were used in the manufacture of arrows for war purposes or large game. In the Willamette Valley the plant is common and is known under the names "arrow wood," "flowering shrub," and "sweet syringa;" on the plains side of the Cascades, it grows at Wocus Bay, near the head of Upper Klamath Lake.

Ribes aureum Pursh.

Chōms′-käm.—The yellow-flowered currant common along streams. The sharply acid berries, chōm′-chäk, which vary in color at maturity from yellow to red or even purplish, are used for food.

Ribes cereum Dougl.

Chmâr′-läk.—A common currant of upland soils, with a bright red, almost tasteless, but juicy and mucilaginous berry. It is frequently gathered for food. For the probable use of the wood for arrow tips, see *Phragmites phragmites.*

Ribes oxyacanthoides saxosum (Hook.) Coville.

Lhō-lō′-ē lō′-ē-säm.—The only gooseberry of the region, and locally known as such among the white people. It is a common shrub in moist bottom lands among willows and other bushes, bearing a smooth, reddish amber-colored berry 6 to 10 mm. (one-fourth to two-fifths of an inch) in diameter, with a faint bloom or glaucousness and a pleasant, slightly acid taste. It is eaten fresh or dried by the Indians, and among white people also is a favorite berry.

ROSACEAE.

Amelanchier alnifolia Pursh.

Chäk′-äm.—The common sarvice berry or service berry of the region. It occurs abundantly on rocky slopes, on the edges of forests, and along streams in almost all parts of the reservation. The fruit, chäk, is gathered in large quantities in August, spread out on mats to dry, and kept for winter use. When fresh the juicy berries, which are ot a dark purple color with a bloom, nearly spherical or somewhat obpyriform, have a sweet, pleasant taste similar to that of a huckleberry, but with a much less pronounced flavor. The objectionable feature of the berry is its large seeds, which are similar to those of an apple, though smaller, and become mucilaginous when chewed.

Cercocarpus ledifolius Nutt.

Yök′-mä-läm.—The well-known mountain mahogany of the region, oftener called simply mahogany, a small tree commonly 3 to 5 meters (10 to 16 feet) in height, common in openings of the yellow-pine forests, particularly at their lower elevations. The exceedingly hard wood of the tree was formerly used for root diggers or camas sticks, and for the heads of fish spears.

The coast species, *C. betulaefolius* Nutt., crosses the Cascade Range through the valley of Klamath River, and may have been used also among these Indians. It has large toothed leaves similar to those of a birch or alder, while *C. ledifolius* has small, narrow, entire leaves with revolute margins.

Fragaria virginiana Duchesne.

Jō′-i-jiks.—The native strawberry. This fruit is eaten fresh only. The Klamaths do not dry it as they do most of their other fruits. The strawberry is not abundant in this region, but occurs here and there in patches in the yellow-pine woods.

Kunzia tridentata (Pursh) Spreng.

Chäk′-lō.—A shrub commonly 1 to 1.5 meters (about 3 to 4½ feet) in height, of a much darker green color than sagebrush (*Artemisia tridentata*), with 3 toothed leaves, and yellow five-petaled flowers nearly an inch in diameter. It is a characteristic plant of the yellow pine forest and extends to somewhat lower altitudes in the upper parts of the sagebrush belt proper. From the fact that it is a reputed favorite food of the antelope, it often passes under the name "buck brush." The roots after steeping in water are drunk as a remedy for coughs and other lung and bronchial troubles. I was informed by an Indian that this is the best medicine they have for this class of complaints. They "use it all the time."

The dry ripe fruits, which are intensely bitter, mashed in cold water and drunk are sometimes used as an emetic. The purple stain derived from the outer seed coat is also sometimes used to produce a temporary color on arrows, bows, and other objects.

Prunus demissa (Nutt.) Walp.

De-wich′-käsh.—The common chokecherry of the West, abundant in openings of the yellow-pine forests, particularly along streams. The wood is known as de-wich′-ksäm. The ripe fruit is an important article of food, being gathered in large quantities in September, and dried.

Prunus emarginata (Dougl.) Walp.

Wö-dō-ghōt′-säm.—The wild bitter cherry of the region, occurring abundantly throughout the yellow-pine forest and sometimes forming dense thickets as high as a man. Its bright red, juicy fruit, about the size of a garden pea, has an intensely bitter taste which has given rise to the local name "quinine cherry." The Indian name is derived from wö-dō-ghōts′, whip, because the slender branches are so often used for whips. The name wit-am′-mäm ē′-wäm, given me by one Indian, the derivation being wit-am′-mäm, bear, and ē′-wäm, berry, was not known to my other informant.

Prunus subcordata Benth.

To-mö′-lö.—The wild red plum of Oregon, abundant in openings of the yellow-pine forests throughout the reservation, but particularly at Modoc Point. By the aborigines it was eaten either dry or fresh, and among the white ranchers it is a common and favorite fruit for stewing. It resembles in flavor some of the sour cultivated plums, but has an additional slightly bitter taste.

Rosa fendleri Crepin.

Chö-it′-i-äm.—The common wild rose of the region. The fruit is occasionally eaten, while the stems are sometimes used for light arrow shafts or for pipestems.

Rubus leucodermis Dougl.

Mäs′-lä.—This was the name given me for a plant said to be a raspberry. It was described as growing at Modoc Point, on the eastern shore of Klamath Lake, reaching a height of about a meter (3 or 4 feet), and bearing a bluish-black berry. The Indians now eat them fresh, and formerly were in the habit of drying them also.

Rubus vitifolius Cham. & Schlecht.

Tö-tänk′-säm.—This is the Indian name given me at different times by different Indians as the proper designation for the blackberry. It is said to be used for food, but I did not learn where it grows.

LINACEAE.

Linum lewisii Pursh.

Kōl′-ä-käms, or *kōl′-käms.*—The Rocky Mountain flax, a perennial plant with slender, little-branched stems about half a meter (1½ to 2 feet) in height, numerous small narrow leaves, and large blue flowers about 2 cm. (nearly an inch) in diameter. The stems produce a remarkably strong fine fiber which is made into strings and cords. These are employed in certain parts of baskets and mats, in the meshes of snowshoes, and in the weaving of fish nets. (See under *Salix* and *Carex.*)

The plant grows in openings of yellow-pine forests and in the upper altitudes of the sage plains, and could doubtless be propagated successfully in such areas without irrigation. It deserves careful experiment as a source of commercial fiber.

RHAMNACEAE.

Ceanothus prostratus Benth.

Ga-ga′-e-säm sä′-wäls.—A prostrate shrub, common in most parts of the yellow-pine forest, forming broad, dense mats not more than a decimeter (4 inches) in height, and known in some parts of California as "mahala mats." The plant has no use among the Indians. Its name, however, is interesting on account of its derivation from ga-ga′-es, hawk; äm, plant, and sä′-wäls, arrowhead—from the saying among the Indians that in the old days when the animals lived like men the hawks used the leaves of this plant for arrowheads. The significance of this saying is evident from the thick, holly-like, coarsely toothed leaves which closely resemble an inverted arrowhead of a certain type.

Rhamnus purshiana DC.

Sär′-um-bäk-ish.—A tall shrub usually 2 to 3 meters (about 6 to 10 feet) high, with black-skinned berries, their flesh soft, greenish, and insipid or slightly bitter, common in moist woods and rocky places along streams in the western part of the reservation, abundant between the agency and the old fort, and at Modoc Point. The bark of this plant is commercially used in medicine under the Spanish name cascara sagrada, though in this part of Oregon it apparently was not gathered for the market. The foliage, twigs, and bark are made into a tea by the Indians and used as an emetic. The berries also act as an emetic.

LOASACEAE.

Mentzelia albicaulis Dougl.

Lō′-läs.—A branching annual with roughly canescent pubescence, pinnatifid leaves, white or nearly white stems, and small yellow orange-centered flowers, common in cultivated ground and old fields. The minute, grayish seeds are much used for food.

ONAGRACEAE.

Oenothera hookeri Torr. & Gr.

Wä′-säm chōn′-wäs.—The native evening primrose of the region, a common weed in cultivated ground and in waste places around dwellings. Its yellow flowers, which open at night, are about 7.5 cm. (3 inches) in diameter. The Klamath name of the plant, derived from wäs, coyote, äm, plant, and chōn-wäs, vomit, is associated with the following story, in which I have retained as nearly as possible the sentiment and sequence of the Indian narrator. A long time ago, when the animals lived and talked like men, the coyote, or prairie wolf, who was very keen and smart, but a good deal of a sneak, just as he is to day, met one day the Indian Christ, Isis, who could do anything he wanted to—could make flowers, "grub" (i. e., food), anything. The coyote said, in a bragging way, that he, too, could do these things just as well as Isis, and Isis said: "Very well, go ahead and make a flower." Then the coyote, who knew that he really couldn't make much of anything, was greatly ashamed, but he went off in the grass a little way and vomited, and on that spot pretty soon this great, rank, yellow-flowered weed came up. And that was the best the smart coyote could do.

APIACEAE.

Carum gairdneri (Hook. & Arn.) Gray.

Ndälk.—A plant closely related to épâ (*Carum oreganum*), and so much like it as not to be distinguishable to an unpracticed eye. Épâ has shorter, stouter roots than ndälk, and a slightly different taste. The roots are a common article of food not only among the Klamaths, but among the Umatillas, who call it sâ-hwēt′; among the Utes, who call it yam′-pä, and in many other tribes.

Carum oreganum Wats.

E′-pâ.—A slender, white-flowered, umbelliferous plant, without a popular English name, but rather commonly known among the whites by its Indian designation. This is one of the earliest spring plants gathered for food, the roots being dug about the 1st of May, at which time the contents are soft and milky. The root is commonly dried and eaten raw. (See also *Carum gairdneri.*)

Cicuta maculata L.

Skä′-wänks.—One of the species of water hemlock, white-flowered, umbelliferous plants, common in swamps and along streams, the roots containing a deadly poison. It is not clear from the specimens collected whether the species of the Klamath country is *maculata* or some very closely related one. The roots mashed and mixed with poison from a rattlesnake's poison sacs or with the decomposed liver of a deer or some other animal, which has been buried in the ground a few days, was used to poison war arrows, the heads of the arrows being dipped in the moist mixture and dried over a special kind of fire with a certain ceremonial. Cicuta was sometimes used among Indians to poison people in very much the same way as arsenic or other well-known poisons are used in civilized communities. It was also stated that pieces of dead fish dried in a certain manner (my informant did not know exactly how) are a deadly poison when taken in food.

Cicuta roots have the reputation of killing horses and cattle. In tramping in marshes where the plants abound, the animals crush the roots, and the poisoned water in the hoof holes is afterwards drunk or the exposed roots eaten.

Heracleum lanatum Michx.

Pöd′-chō.—Not identified, but perhaps the cow parsnip, a coarse, rough-hairy, umbelliferous plant growing in moist meadows. The young shoots when about 15 cm. (6 inches) high are used for food, and the roots are employed medicinally. The plant was said to grow at Modoc Point on Klamath Lake.

Peucedanum canbyi Coult. & Rose.

Lhe′-häs.—A low umbelliferous plant with white flowers, finely dissected leaves, and tuberous roots. This is a food used comparatively little among the Klamaths, but a staple article among the Modocs at the Yainax subagency, who gather it in the neighborhood of Lost River and Tule Lake, in Klamath County. The sample that came to the writer's notice was a long necklace-like string of the roots which a Klamath Indian had brought from Yainax. The product is often handled in this form as well as loose in sacks. Each root is shaped like an onion, with a diameter of 2 to 3.5 cm. (about ¾ to 1½ inches), of a yellowish or buff color on the cross-veined surface, after the removal of the blackish outer skin, and a creamy white color within. The interior has a mealy and slightly spongy appearance, is soft enough to be easily masticated without other preparation than drying, and has a faintly carrot-like taste. It belongs, indeed, to the same family as the carrot and parsnip. The roots are eaten in their simple dried form or are mashed and boiled into a mush.

Sium cicutaefolium Gmel.

Wâ′-küm.—A common marsh perennial, commonly a meter in height, with simply pinnate leaves and dentate leaflets, the white flowers borne in compound umbels. The herbage of this plant, which has an aromatic flavor, is eaten as a relish.

ERICACEAE.

Arctostaphylos patula Greene.

Shle-shläp′-shäm.—The common manzanita of the yellow-pine forests, growing to a height of 1 to 1.5 meters (about 4 or 5 feet) and often forming dense thickets. Its broad, evergreen leaves, red berries, and smooth, red-brown bark make it a conspicuous and handsome shrub. The green berries are sometimes eaten, and the leaves, picked and dried at any season, are mixed with tobacco for smoking.

Arctostaphylos nevadensis Gray.

Kā-mä′-mī—The bearberry, a small, red-stemmed shrub closely resembling the manzanita in leaves and berries, but creeping on the ground and seldom rising more than 20 cm. (about 8 inches) above it. Its dried leaves mixed with tobacco are used for smoking. A closely related species, *Arctostaphylos uva-ursi* (L.) Spreng., occurs in northern latitudes all the way across the continent, and was one of the favorite tobacco mixtures of many other tribes. This species grows in the Cascade Mountains of middle and northern Oregon, but so far as known does not occur in the neighborhood of the Klamath Reservation. *A. nevadensis* is abundant along the road from Fort Klamath to Crater Lake, above the yellow-pine forests.

Vaccinium membranaceum Dougl.

Ē'-wäm.—The common tall huckleberry of the mountains, commonly a meter in height, with large, finely serrate leaves, acute at the apex, and a purple-black luscious fruit. About the third week in August nearly all the old women of the Klamath tribe and many whole families cross the divide of the Cascades by way of Anna Creek to Huckleberry Mountain or Ē'-wäm-can, the place of the huckleberries, a few miles southwest of Crater Lake. Here they spend a few weeks picnicking, feasting, and gathering and drying their supply of huckleberries for winter use.

Vaccinium scoparium Leiberg.[1]

A low huckleberry of the forested mountain slopes, seldom 30 cm. high, with angular stems, small leaves, and sweet red fruit. The berries are eaten either fresh or dried.

APOCYNACEAE.

Apocynum cannabinum L.

Nōt, the o much prolonged. Knowing that this milky-juiced plant was widely used among the American aborigines as a source of one of their best fibers, and not learning of its use among the Klamaths, I described it to a very intelligent Indian, who then recollected that a fiber plant agreeing with my description occurred in the Lost River country south of the reservation and was used by the Modocs. No opportunity was afforded, however, to verify the identification.

POLEMONIACEAE.

Gilia aggregata (Pursh) Spreng.

Ōhl'-säm bōn'-wäs.—A beautiful scarlet-flowered biennial plant of the yellow-pine belt, about 50 cm. high (approximately 18 inches), with finely divided leaves and a tubular, funnel-form corolla, commonly 3 cm.

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[1] This is Hooker's variety *microphyllum* of *Vaccinium myrtillus*, which, with its lower stature and broom-like habit, smaller leaves, obsolescent calyx lobes, and red fruit, appears specifically distinct from *V. myrtillus*. On account of the older *Vaccinium microphyllum* of Reinwardt, a new specific name, from Mr. Leiberg's manuscript, is here adopted.

(about 1¼ inches) in length. The name, from ōhls, dove, äm, plant, and bōn-wäs, drink, commemorates the legend, current among the Indian children, who pluck the flowers and suck the nectar, that in the old days when the beasts and birds lived together and understood each other's language the wild dove's drink was the nectar of this flower, and nothing else.

NEPETACEAE.

Mentha canadensis L.

Mäch-äs'-säm.—The native true mint, frequent in the borders of marshes. A tea is made from its herbage.

SCROPHULARIACEAE.

Nicotiana attenuata Wats.

Käch'-kul.—The native wild tobacco of the region, commonly appearing as a weed in cultivated fields. My informant stated that the Indians never cultivated it, and that it makes an exceedingly strong smoking mixture.

VIBURNACEAE.

Lonicera conjugialis Kell.

Ō'-täm.—One of the bush honeysuckles, locally but incorrectly known as "cranberry," a common plant in moist, open forests of lodgepole pine, *Pinus murrayana.* It occurred in considerable abundance at several points between the agency and Fort Klamath post-office.

The red or purplish berries, which have a mild, sweet flavor, are eaten fresh, but not to a great extent. They are never dried.

Sambucus glauca Nutt.

Slō'-lös.—The common elder of the region, which bears large clusters of pale-blue berries, densely covered with bloom or glaucousness. The berries, slō'-lö-säm, are an article of food.

One curious use of the plant, now rarely resorted to, but formerly common among the Snake Indians, consists in punching out the pith from sections of the stem, ramming them full of large crickets, *Anabrus simplex* Hald., and plugging the ends. The contents of the stems were used for food in the winter.

VALERIANACEAE.

Valeriana edulis Nutt.

K-ōl'.—A perennial with a thick, deep root, deeply linear-lobed basal leaves, and a nearly leafless stem, bearing at the summit a close cyme of white flowers, these becoming long-stalked in age and ripening into small feathered nutlets. It grows along streams and in natural meadows; for example, along Wood River, between the agency and the old fort. In cooking, a hole perhaps a meter or more (about 3 or 4 feet) in diameter and half as deep is dug in the ground and lined with stones. A fire is then built in the hole, and after burning for a sufficient time is cleared out. Fresh grass is next laid over the hot stones, then k-ōl′, then more grass, and the whole covered with earth. The mass is then allowed to cook and steam the rest of the day and over night, when the pit is opened and the cooked roots are ready for eating.

The odor of the root is very disagreeable to white people, to such a degree, indeed, that the use of the plant about the agency was formerly forbidden.

The Snake name of the plant is kwē′-yä.

CARDUACEAE.

Achillea millefolium L.

Läl-wäl′-säm.—Yarrow, a weed common in meadows and pastures in the Eastern United States, and, from the evidence of its occurrence even in very remote and unsettled parts of the plains and from the statements of the Indians, unquestionably native in our Northwest. Many years ago, before the building of mill and irrigation dams, when the salmon ran up Williamson and Sprague rivers and the Indians were in the habit of drying them, it was their custom, after a fish was split open, to lay in the body cavity a yarrow stem with its leaves and flowers still attached. This treatment, by holding the fish open, hastens the drying process and prevents the decomposition that would be likely to follow if the walls were allowed to collapse. My informant knew of no special significance attached to the use of this particular plant and of no special adaptability it had for this purpose, except that it did not give the dried fish such a bad taste as some other plants.

Artemisia tridentata Nutt.

Ghät, or *bōl′-whē.*—The largest, most abundant, and most widely distributed species of sagebrush, composing probably nine-tenths of the shrubby vegetation of the plains of southeastern Oregon. In medicine a decoction of the herbage is used internally to check diarrhea, externally as an eyewash, while the mashed herbage is used as a substitute for liniment.

In the production of fire on wood by friction, the ordinary method of obtaining fire before the advent of the white man and still occasionally resorted to, small dead stems of it are used as twirling sticks, this being the most widely used and satisfactory wood for the purpose.

Away from the timber, sagebrush is the almost universal fuel of the region, not only among the aborigines, but among the white ranchmen. The short trunks, often 10 cm. (4 inches) in diameter, but more commonly one-half to two-thirds as much, have a wood of not very great solidity, which, assisted by the loose stringy bark, takes fire readily and produces fairly good coals.

Tetradymia canescens DC.

Kat-kat′-säm.—A composite yellow-flowered shrub, 1 to 2 feet in height, with silvery white, oblanceolate leaves, blooming in July and August. This is often eaten by horses, but otherwise it is a plant of no importance to the Indians.

Wyethia mollis Gray.

Stä′-mäk.—A plant very similar to Balsamorrhiza, but the canescent leaves not cordate at the base. It is abundant in the yellow-pine forests. The roots of a plant, which from the description is probably this, are mashed and used as a poultice for swellings.

Balsamorrhiza sagittata (Pursh) Nutt.

Lbä.—A stout low plant, about 30 to 50 cm. (approximately 1 to 1½ feet) high, with yellow flower heads similar to a small sunflower, and large, grayish, arrow-shaped leaves often 30 cm. long, the whole plant resembling the introduced elecampane, *Inula helenium* L., of our Eastern pasture lands. Horses have a marked fondness for these leaves and are continually cropping them while under the saddle. The seeds of this plant and those of the similar *B. deltoidea* Nutt., which the Indians do not distinguish from it, are gathered, roasted, and ground as a farinaceous food. Both plants are abundant on the reservation in the yellow-pine forests.

Chondrophora nauseosa (Pursh) Britton.

Wäl′-wäl.—One of the plains shrubs known as rabbit brush. A silvery-white variety of this species about 4 feet high, with narrowly linear leaves, and bearing yellow composite flowers in September, is common in the margins of the yellow-pine forests about the agency. Its mashed herbage, aromatic and resinous, is used to raise blisters.

Chrysothamnus bloomeri (Gray) Greene.

Wä′-mi.—A yellow-flowered composite shrub, 1 to 3 feet high, with slender, bright green foliage. A poultice of the mashed leaves and flowers is used to draw blisters. The name appears to be applied also to other related shrubs containing aromatic-resinous principles, and used in a similar manner.

Madia glomerata Hook.

Gō′-ē-whä.—A glutinous, yellow-flowered, composite annual plant, one of the several species called "tarweed." The seeds are often used for food.

ALPHABETICAL LIST OF INDIAN NAMES, WITH THEIR TECHNICAL EQUIVALENTS.

Bä	Abies concolor.
Ba-bäk″-bak-lha′-näm	Eriogonum stellatum.
Bä-bä′-ö-säm	Berberis repens.
Ba-lō′-ōch	Amarantus blitoides.
Bä′-näm	Abies concolor.
Bha′-nē	Carex.
Bōl′-whē	Artemisia tridentata.
Chäk′-äm	Amelanchier alnifolia.
Chäk′-lō	Kunzia tridentata.
Chäp′-tö	Beckmannia crucaeformis.
Chēp′-äs	Sisymbrium incisum.
Chmâr′-läk	Ribes cereum.
Chö-ä′	Sagittaria arifolia.
Chö-it′-i-äm	Rosa fendleri.
Chōm′-chäk	Ribes aureum.
Chōms′-käm	Ribes aureum.
De-wich′-käsh	Prunus demissa.
De-wich′-ksäm	Prunus demissa.
E′ pâ	Carum oreganum.
Ē′-wäm	Vaccinium membranaceum.
Ga-ga′-e-säm sä′-wäls	Ceanothus prostratus.
Gä′-ö gä′-ö-säm	Berberis repens.
Ghä′-gum läk′-ō	Iris missouriensis.
Ghät	Artemisia tridentata.
Gil-lēn′-ä	Triglochin maritima.
Gla′-i-pi	Elymus condensatus.
Gla′-i-pi-äm″	Elymus condensatus.
Gō′-ē-whä	Madia glomerata.
Gō′-klaks	Rumex salicifolius.
Jō′-i-jiks	Fragaria virginiana.
Kā′-a-lum-kēs	Eriogonum elatum.
Käch′-kul	Nicotiana attenuata.
Käm′-chö-dā″-lis	Panicularia fluitans.
Kā-mä′-mī	Arctostaphylos nevadensis.
Käp′-i-önks	Polygonum douglasii.
Käp′-kä	Pinus ponderosa.
Kat kat′-säm	Tetradymia canescens.
Ken-ä′-wät	Rumex geyeri.
Khä-äls′	Carex.
K-ōl′	Valeriana edulis.
Kōl′-ä-käms	Linum lewisii.
Kōl′-käms	Linum lewisii.
Kō-osh′	Populus balsamifera.
Kōts-on′-iks	Chenopodium fremonti.

Ktā′-lō	Pinus lambertiana.
Kwē′-yä	Valeriana edulis.
Läl-wäl′-säm	Achillea millefolium.
Lbä	Balsamorrhiza sagittata.
Lhō-lō′-e lō′-ē-säm	Ribes oxyacanthoides saxosum.
Lō′-läs	Mentzelia albicaulis.
Mäch-äs′-säm	Mentha canadensis.
Mä′-ēm lä′-wäls	Scirpus lacustris occidentalis.
Mä′-i	Scirpus lacustris occidentalis.
Mäs′-lä	Rubus leucodermis.
Ndälk	Carum gairdneri.
Nkōs	Pinus ponderosa.
N̦ōt	Apocynum cannabinum.
Nō′-täk	Agrostis perennans.
Ōhl′-säm bōn′-wäs	Gilia aggregata.
Ō′-täm	Lonicera conjugialis.
Pâks	Quamasia quamash.
Pöd′-chō	Heracleum lanatum.
Pō′-päs	Typha latifolia.
Sâ-hwēt′	Carum gairdneri.
Sär′-um-bäk-ish	Rhamnus purshiana.
Scä′-ō	Zygadenus venenosus.
Scou	Zygadenus venenosus.
Shäl	Phragmites phragmites.
Shle-shläp′-shäm	Arctostaphylos patula.
Shwā′-wi-säm	Evernia vulpina.
Skä′-wänks	Cicuta maculata.
Sleds	Urtica breweri.
Slō′-lös	Sambucus glauca.
Slō′-lö-säm	Sambucus glauca.
Stä′-mäk	Wyethia mollis.
Stop′-älch	Pinus ponderosa.
Tkōp	Phragmites phragmites.
To-mö′-lö	Prunus subcordata.
Tö-tänk′-säm	Rubus vitifolius.
Tsäl	Phragmites phragmites.
Tsin-ä′-ō	Juncus balticus.
Tsö-pink′-shäm	Taxus brevifolia.
Vö′-läl	Populus tremuloides.
Wä-chäk′-wis	Equisetum hyemale.
Wâ′-käm	Sium cicutaefolium.
Wä′-kō	Pinus murrayana.
Wöl′-wäl	Chondrophora nauseosa.
Wä′-mi	Chrysothamnus bloomeri.
Wä′-säm chōn′-wäs	Oenothera hookeri.
Wich′-pī	Carex.
Wip′-läm	Alnus tenuifolia.
Wit-am′-mäm ē′-wäm	Prunus emarginata.
Wö-dō-ghōt′-säm	Prunus emarginata.
Wō-käs	Nymphaea polysepala.
Wöl′-wänsh	Libocedrus decurrens.
Wöl′-wän′-shäm	Libocedrus decurrens.
Yam′-pä	Carum gairdneri.
Yänch	Calochortus macrocarpus.
Yäs	Salix.
Yä′-yäk	Salix.

INDEX.

Page.
Abies concolor 88
Achillea millefolium 105
Agrostis perennans 91
Alectoria fremontii 87
Alismaceae 90
Alder 94
Alnus tenuifolia 94
Amarantaceae 96
Amaranth 95
Amarantus blitoides 96
Amelanchier alnifolia 97
Apiaceae 101
Apocynaceae 103
Apocynum cannabinum 103
Arctostaphylos nevadensis 102
    patula 102
    uva-ursi 103
Arrowhead 90
Arrow wood 97
Artemisia tridentata 88, 98, 105
Aspen 94
Balsamorrhiza deltoidea 106
    sagittata 106
Bearberry 102
Beckmannia erucaeformis 91
Berberidaceae 96
Berberis repens 96
Betulaceae 94
Blackberry 99
Blue flag 93
Brassicaceae 96
Buckbrush 98
Bur-reed 90
Calochortus macrocarpus 93
Camas 93
    poison 93
    white 93
Canaigre iii
Carduaceae 105
Carex 92
Carum gairdneri 101
    oreganum 101
Cascara sagrada iii, 100
Castanopsis chrysophylla minor 94
Cat-tail 90
Cat-tail flag 90
Ceanothus prostratus 100
Cedar 88
    red 88
Cercocarpus betulaefolius 98
    ledifolius 93, 98
Chenopodiaceae 95
Chenopodium fremonti 95

Page.
Chenopodium quinoa 96
Cherry, wild bitter 98
    quinine 99
Chinquapin 94
Chokecherry 93
Chondrophora nauseosa 106
Chrysothamnus bloomeri 106
Cicuta 101
    maculata 101
Corylus californica 94
Cottonwood 94
Cow parsnip 101
Cranberry 104
Currant 92, 97
Cyperaceae 92
Dock 95
Elder 104
Elecampane 106
Elymus condensatus 91
Equisetaceae 88
Equisetum hyemale 88
Ericaceae 102
Eriogonum elatum 95
    stellatum 95
Evening primrose 100
Evernia vulpina 88, 92
Fagaceae 94
Fir, white 88
Flax, Rocky Mountain iii, 92, 99
Flowering shrub 97
Fragaria virginiana 98
Gilia aggregata 103
Gooseberry 97
Goosefoot 95
Grass 91
    cane 91
    marsh 91
    sugar 91
    rye 91
Hazlenut 94
Heracleum lanatum 102
Huckleberry 89, 103
Indian corn iii
Inula helenium 106
Iridaceae 93
Iris missouriensis 93
Istle iii
Juncaceae 92
Juncus balticus 92
Juniperus occidentalis 88
Kunzia tridentata 98
Lamb's quarters 95
Libocedrus decurrens 88, 89

Page.

Lichen ... 87, 88, 92
Lichenes ... 87
Liliaceae ... 93
Linaceae ... 99
Linum lewisii ... 92, 94, 99
Loasaceae ... 100
Lobelia ... 93
Lonicera conjugialis ... 104
Madia glomerata ... 106
Mahala mats ... 100
Mahogany ... 98
  mountain ... 98
Manzanita ... 102
Mentha canadensis ... 104
Mentzelia albicaulis ... 100
Mint ... 104
Moss, black ... 87
  yellow ... 88
Nepetaceae ... 104
Nettle ... 95
Nicotiana attenuata ... 104
Nymphaea polysepala ... 96
Nymphaeaceae ... 96
Oenothera hookeri ... 100
Onagraceae ... 100
Oregon grape ... 96
Panicularia fluitans ... 91
Parsley family ... iii
Peucedanum canbyi ... 102
Philadelphus lewisii ... 97
Phragmites phragmites ... 91
Pinaceae ... 88
Pine, black ... 87, 89
  lodgepole ... 87, 89, 104
  sugar ... 88
  tamarack ... 89
  yellow ... 88, 89, 106
Pine-lichen, yellow ... iii
Pinus lambertiana ... 88
  murrayana ... 87, 89, 104
  ponderosa ... 89
Plum, wild red ... 99
Poaceae ... 91
Polemoniaceae ... 103
Polygonaceae ... 95
Polygonum douglasii ... 95
Poplar, balm of gilead ... 94
Populus balsamifera ... 94
  tremuloides ... 94
Potato ... iii, 90
Prunus demissa ... 98
  emarginata ... 98
  subcordata ... 99
Quaking asp ... 94
Quamasia quamash ... 93
  leichtlinii ... 93
Rabbit brush ... 106
Raspberry ... 99
Reed ... 91
Rhamnaceae ... 100

Page.

Rhamnus purshiana ... 100
Ribes aureum ... 97
  cereum ... 92, 97
  oxyacanthoides saxosum ... 97
Rosaceae ... 97
Rosa fendleri ... 99
Rose, wild ... 99
Rubus leucodermis ... 99
  vitifolius ... 99
Rumex geyeri ... 95
  salicifolius ... 95
Rush ... 92
Sagebrush ... 98, 105
Sagittaria arifolia ... 90
  latifolia ... 90
Salicaceae ... 94
Salix ... 94
Sambucus glauca ... 104
Sarvice berry ... 97
Saxifragaceae ... 97
Scheuchzeriaceae ... 90
Scirpus lacustris occidentalis ... 92
Scrophulariaceae ... 104
Sedge ... 92
Service berry ... 97
Sisymbrium incisum ... 96
Sium cicutaefolium ... 102
Slew-grass ... 91
Sparganiaceae ... 90
Sparganium eurycarpum ... 90
Strawberry ... 98
Sweet syringa ... 97
Tarweed ... 106
Taxaceae ... 89
Taxus brevifolia ... 89
Tetradymia canescens ... 106
Tobacco ... 93, 102
  wild ... 104
Triglochin maritima ... 90
Tule ... 92
Typha latifolia ... 90
Typhaceae ... 90
Urtica breweri ... 94, 95
Urticaceae ... 95
Vaccinium membranaceum ... 103
  microphyllum ... 103
  myrtillus microphyllus ... 103
  scoparium ... 103
Valeriana edulis ... 93, 104
Valerianaceae ... 104
Viburnaceae ... 104
Wappatoo ... 90
Water hemlock ... 101
Water lily, yellow ... 96
Willow ... 94
Wyethia mollis ... 106
Yarrow ... 105
Yew ... 89
Zygadenus venenosus ... 93

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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

THE U. S. NATIONAL HERBARIUM.

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STUDIES OF MEXICAN AND CENTRAL AMERICAN PLANTS.

BY

J. N. ROSE.

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1897.

U. S. National Museum 2-9-134

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Botany,
Washington, D. C., June 26, 1897.

Sir: I have the honor to submit herewith the manuscript of a pap by Dr. J. N. Rose, assistant curator of the United States Nation Herbarium, entitled Studies of Mexican and Central American Plant and to recommend its publication as Contributions from the Unit States National Herbarium, Volume V, No. 3.

Respectfully,

Frederick V. Coville,
Botanist.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.

- Studies of Mexican and Central American Plants 10
- Prefatory note 10
- Notes on Celastraceae 10
- Notes on Rutaceae 11
  - Esenbeckia 11
  - Species of other Genera 11
- Notes on Burseraceae 11
- Notes on Cucurbitaceae 11
  - Echinopepon and its Allies 11
    - Echinopepon 11
    - Vaseyanthus 11
    - Brandegea 12
    - Species of other Genera 12
  - Miscellaneous Genera and Species 12
    - Pittiera 12
    - Schizocarpum 12
    - Species of other Genera 12
- A synopsis of the species of Heliocarpus 12
- A synopsis of the species of Wimmeria 12
- A synopsis of the American species of Hermannia 13
- A synopsis of Drymaria nodosa and its Allies 13
- Descriptions of Miscellaneous New Species 13

ILLUSTRATIONS.

PLATES.

Page.
Plate II. *Esenbeckia macrantha* Rose 111
III. *Esenbeckia acapulcensis* Rose 111
III. *Esenbeckia berlandieri* Baillon 111
IV. *Echinopepon pringlei* Rose 117
V. *Pittiera parvifolia* Rose 123
VI. *Schizocarpum attenuatum* Rose 124
VII. *Heliocarpus americanus* L 125
VIII. *Heliocarpus occidentalis* Rose 127
IX. *Heliocarpus reticulatus* Rose 128
X. *Heliocarpus pallidus* Rose 129
XI. *Abutilon bakerianum* Rose 133
XII. *Abutilon nelsoni* Rose 134
XIII. *Brongniartia suberea* Rose 134
XIV. *Crotalaria filifolia* Rose 136
XV. *Cuphea nelsoni* Rose 137
XVI. *Gymnogramme subcordata* Eaton & Davenport 138
XVII. *Passiflora nelsoni* Rose 142

TEXT FIGURES.

Fig. 1. *Cassia nelsoni* Rose 135
2. *Gouania pallida* Rose 138
3. *Gouania stipularis* DC 138
4. *Hiraea polybotrya* Juss 139
5. *Mimosa lacerata* Rose 141
6. *Pseudosmodingium multiflorum* Rose 143

STUDIES OF MEXICAN AND CENTRAL AMERICAN PLANTS.

By J. N. Rose.

PREFATORY NOTE.

Owing to the large number of sources from which plants are sent to us from Mexico, it seems advisable to discontinue, at least for the present, the publication of reports upon separate collections from that quarter. There is the added reason that many of the species are absent from even our largest American herbaria, which makes the identification doubly tedious. It is my plan, therefore, to work up the various collections jointly, reporting upon them somewhat irregularly by genera or families, presenting revisions, synopses, or even monographs, when the material at hand seems to justify it.

Miscellaneous new species will be published from time to time. These studies will be mostly upon the Polypetalae, although not necessarily confined to this group.

NOTES ON CELASTRACEAE.

Maytenus phyllanthoides Benth. Bot. Sulph. 54. 1844.

Shrub 30 to 45 dm. high.

Collected by Mr. C. G. Pringle in calcareous soil, Tehuacan, Puebla, altitude 1,808 meters, December 20, 1895 (No. 6285).

Myginda scoparia Hook. & Arn. Bot. Beech. 283. 1836–40.

Leaves of two kinds; some small, 6 to 10 mm. long, occasionally opposite, mostly alternate; the others much larger, 3.7 cm. or more long, always alternate; flowers small, brownish in color; fruit pear-shaped, 6 mm. long, obtuse, red, 1-seeded.

Not common; in river bottoms and on shaded hillsides. Collected by Dr. Edward Palmer, Acapulco, December, 1894 (No. 170).

This species was omitted by Mr. Hemsley from the Biologia Centrali-Americana. The original specimens came from Acapulco, and there is no doubt of the identity of Dr. Palmer's plant. In the above description we have intended simply to supplement or correct the original characters, which were based on flowering specimens only.

This species has not before been represented in the National Herbarium.

Hippocratea acapulcensis H. B. K. Nov. Gen. & Sp. 5: 157. 1821.

Climbing shrub, 15 to 24 dm. high; leaves dark green, flowers greenish white.

Collected by Dr. Edward Palmer near Acapulco, March, 1895 (No. 629).

This species was originally collected near Acapulco, by Humboldt and Bonpland, and was afterwards obtained there by Lay and Collie.

Mr. Nelson has collected the species in the State of Oaxaca at the following places: valley about Cuicatlan, altitude 590 meters, November 3, 1894 (No. 1863); Jamiltepec to Rio Verde, altitude 131 to 328 meters, February 24, 1895 (Nos. 2373 and 2374).

It has not heretofore been represented in the National Herbarium.

This appears to be *Tontellea hookeriana* Miers and *Pristimera tenella* Miers.

Hippocratea mexicana Miers, Trans. Linn. Soc. 28: 352. 1872.

Sometimes a tree 7.5 to 9 meters high, with trunk 20 cm. in diameter.

Collected by Dr. Edward Palmer near Acapulco, February and March, 1895 (Nos. 430, 584, and 588).

We have seen no named specimens of *H. mexicana*. Mr. Hemsley has referred this species to *H. uniflora* DC.

The identification of the above two species is not at all satisfactory.

Perrottetia longistylis Rose, sp. nov.

Leaves oblong, 12.5 to 15 cm. long, long-acuminate, cuneate at base, coarsely toothed; inflorescence puberulent; sepals narrow, acute; petals ovate, ciliate; style elongated, enlarged at base, 2-lobed.

Collected by Bourgeau in Izhuatlancillo near Orizaba, 1865-6 (No. 2827).

This plant is referred to *P. quindiuensis* by Mr. Hemsley in the Biologia Centrali-Americana, but that species came originally from South America and besides has glabrous petals, stamens shorter than the petals, and the style very short.

Bourgeau's plant is perhaps nearer *P. ovata*, from which it differs in its larger, more acuminate leaves, less ciliate petals, and longer and thicker style.

Perrottetia ovata Hemsl. Diag. Pl. Nov. 1:6. 1878.

Collected by Mr. E. W. Nelson from near Totontepec, Oaxaca, altitude from 1,217 to 1,808 meters, July 15 to 20, 1894 (No. 786); also from about Tumbala, Chiapas, altitude 1,312 to 1,807 meters, October 20 to 29, 1895 (No. 3354).

My material, while presumably of this species, has the leaves oblong rather than broadly ovate. Only the male flowers have been described. The female flowers may be thus characterized: Sepals and petals as in the male flowers, ovary glabrous, style short, stigma two-parted, fruit broader than high, 4-lobed.

Perrottetia glabrata Rose, sp. nov.

A shrub 24 to 30 dm. high, nearly glabrous; leaves oblong, shortly acuminate, glabrous, excepting veins and petiole, or becoming glabrate, rounded at base, sharply and finely serrate, 7.5 cm. or less long, 3.7 to 5 cm. wide, pale beneath; inflorescence glabrous throughout; petals small, slightly ciliate; stamens long.

Collected by E. W. Nelson on Mt. Orizaba, altitude 1,607 to 2,460 meters, March 18, 1894 (No. 313). Here seems to belong Harris's plant which Mr. Hemsley referred to his *P. ovata* in the Biologia Centrali-Americana. *P. ovata* differs from the above species in the reddish pubescence of the inflorescence, the densely ciliate petals, coarser-toothed leaves, etc.

NOTES ON RUTACEAE.

ESENBECKIA

The genus Esenbeckia is said by Bentham and Hooker to contain about 22 species confined to South America and the West Indies. Mr. Hemsley in his enumeration of Mexican plants[1] reports a single species, *E. berlandieri*. In addition to my two new species described below, two others have recently been described, viz: ***E. flava*** and ***E. hart-***

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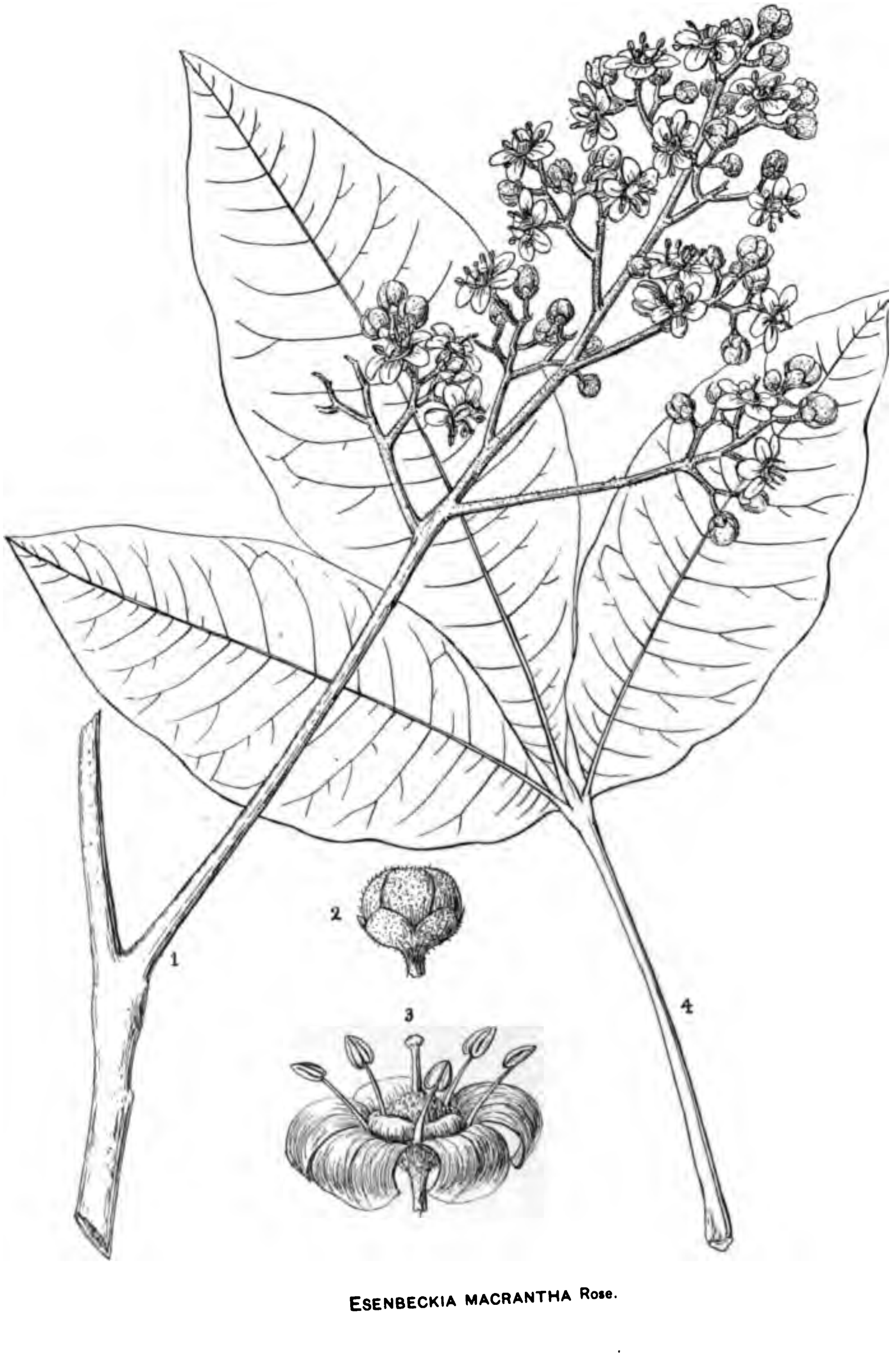
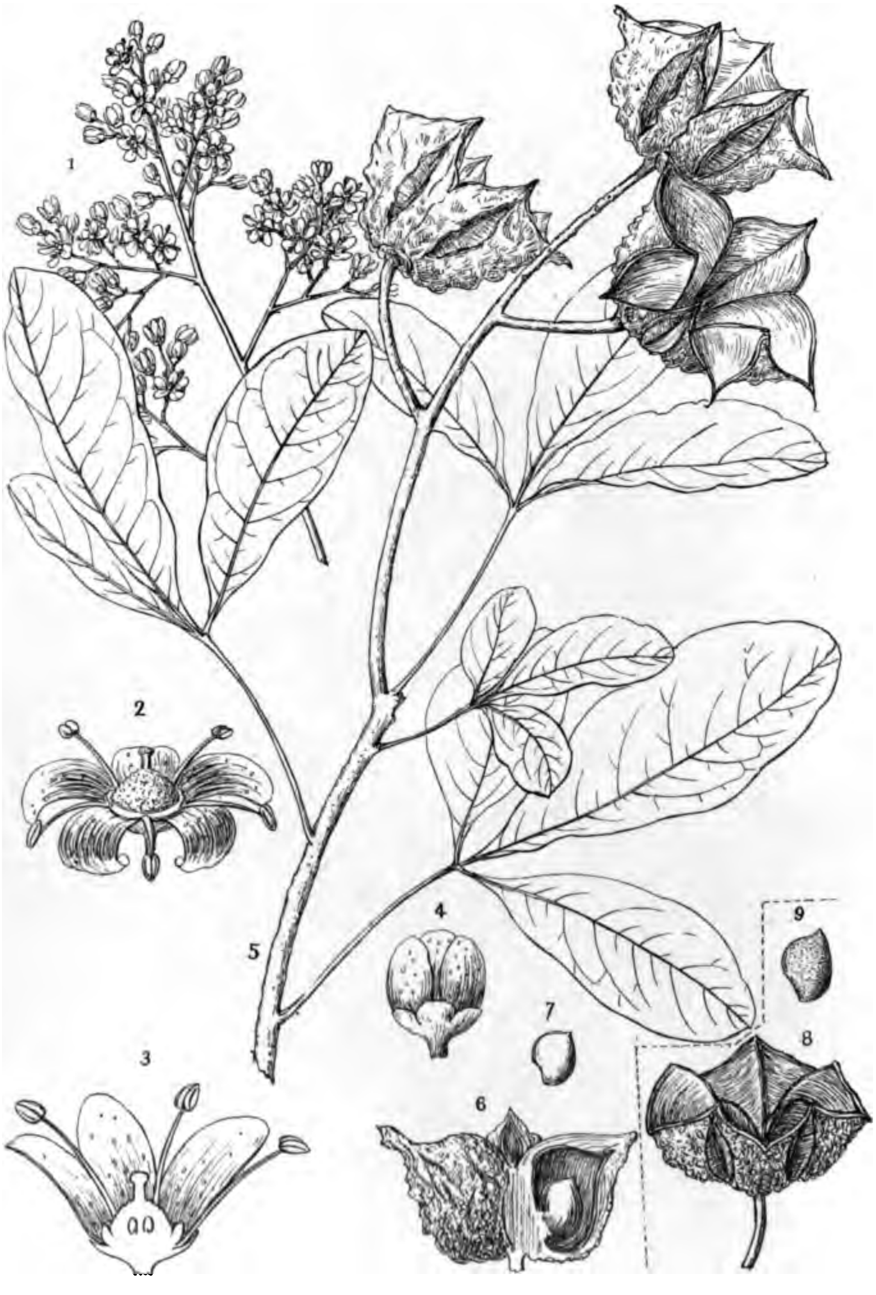
[1] Biol. Centr. Amer. 1: 170.



ESENBECKIA MACRANTHA Rose.



ESENBECKIA ACAPULCENSIS Rose and E. BERLANDIERI Baillon.

manii, making in all five species for Mexico. The following key will be helpful in separating these species:

* *Leaves simple.*

+ *Leaves large, 5 to 10 cm. long, pubescent, pale.*

Esenbeckia flava Brandegee, Zoe, 1:378, *t. 12.* 1891.

Collected by T. S. Brandegee at San Jose del Cabo, Lower California, 1890. Only known from this one collection.

+ + *Leaves small, 2.5 to 5 cm. long, nearly glabrous, bright green, finely reticulated.*

Esenbeckia hartmanii Robinson & Fernald, Proc. Am. Acad. 30:115. 1894.

Type specimens collected by C. V. Hartman, La Tinaja canyon, State of Sonora, November 19, 1890 (No. 240), and since by Dr. Palmer near Culiacan, October 25 to November 18, 1891 (No. 1801).

* * *Leaves ternate.*

+ *Leaflets very large, pubescent beneath, flowers few and large, sepals and petals not pellucid-dotted.*

Esenbeckia macrantha Rose, sp. nov. PLATE II.

A tree 4.5 to 6 meters high; young branches and inflorescence silky-pubescent; leaves alternate, long-petioled, 3-foliolate; leaflets large, oblong, 15 to 20 cm. long, 5 to 7.5 cm. broad, somewhat oblique at base, somewhat acuminate at apex, green and shining above, paler and somewhat silky beneath, covered with small pellucid dots, strongly veined; inflorescence paniculate; sepals 5, small, rounded; corolla 10 mm. broad; petals imbricate, pubescent without; stamens 5; disk very large, slightly lobed.

Collected by Mr. E. W. Nelson in a canyon along wagon road 6 miles above Dominguillo, State of Oaxaca, altitude 1,443 to 1,607 meters, October 30, 1894 (No. 1831).

EXPLANATION OF PLATE.—Fig. 1, flowering branch; fig. 2, flower bud; fig. 3, open flower; fig. 4, leaf; figs. 1 and 4, scale ⅔; figs. 2 and 3 enlarged.

+ + *Leaflets glabrous and smaller, flowers numerous and smaller.*

++ *Sepals and petals pellucid-dotted, petals white, seeds silvery and with a deep concavity at base.*

[1]**Esenbeckia acapulcensis** Rose, sp. nov. PLATE III.

A small tree, 6 meters high; stem 7.5 to 10 cm. in diameter, glabrous throughout; leaves ternate; leaflets oblong to obovate, rounded at apex, somewhat tapering at base into slender petiolules, 3.7 to 12.5 cm. long; flowers abundant, in a short, broad terminal panicle; inflorescence puberulent; sepals nearly orbicular, glabrous, dotted; petals white, thin, dotted; fruit flat-topped, 5 cm. broad, deeply 5-lobed, very much ridged; seeds brownish.

Collected by Dr. Edward Palmer, in river bottoms near Acapulco, December, 1895 (No. 175).

Very different from the two recently described species (*E. flava* and *E. hartmanii*) from western Mexico. It is nearest *E. berlandieri* of eastern Mexico.

EXPLANATION OF PLATE.—Fig. 1, flowering branch; fig. 2, flower; fig. 3, flower dissected; fig. 4, bud; fig. 5, branch with fruit and leaves; fig. 6, fruit; fig. 7, seed; figs. 1 and 5, scale ⅔; figs. 2, 3, and 4 enlarged.

++ ++ *Petals spotted, seeds dull and with a mere scar at base.*

Esenbeckia berlandieri Baill. Adansonia, 10: 151. 1871. PLATE III.

Type specimens from woods near Tampico, Tamaulipas (Berlandier, No. 3125).

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[1] Since the above key was prepared Capt. John Donnell Smith has published *E. litoralis* from Guatemala in the Botanical Gazette (23: 242). I have not seen his specimens but he states that it is most nearly related to *E. acapulcensis*. I should judge that it is clearly distinct.

I have been able to examine a duplicate type of this at the Gray Herbarium. The species, while closely related to the last, appears to be distinct, having somewhat different carpels and seeds, less pellucid leaflets, etc.

EXPLANATION OF PLATE.—Fig. 8, capsule; fig. 9, seed; scale $\frac{4}{3}$.

SPECIES OF OTHER GENERA.

Amyris thyrsiflorus Turcz. Bull. Soc. Nat. Mosc. 21, pt. 1: 475. 1858.

Collected by Mr. E. W. Nelson at San Andres Tuxtla, State of Vera Cruz, altitude 328 meters, May 7, 1894 (No. 453).

This is the only representative we have of this species. It answers the original description fairly well except that the petioles and petiolules can hardly be said to be winged.

The type of this species also came from Vera Cruz.

Pilocarpus longipes Rose, sp. nov.

A shrub 15 to 36 dm. high, glabrous throughout; leaflets 3 to 5, rarely solitary, 5 to 10 cm. long, oblong, obtuse to retuse, broadly cuneate at base, strongly reticulate and glabrous above and beneath; raceme 3 to 5 dm. long; pedicels horizontal in flower, ascending in fruit, 20 to 25 mm. long, glabrous, with 1 or 2 small bracts just beneath the flower; fruit deeply 5-lobed or parted, 1 to 5 maturing; mature coccus glabrous with parallel semicircular grooves, 10 mm. in diameter; seeds black, glabrous, 6 to 8 mm. long.

Collected by Dr. Edward Palmer on shady hillsides near Acapulco, Mexico, February, 1895 (No. 514).

This seems nearest the Brazilian species *P. seloanus*, but has the bracts of the pedicels differently situated, fewer leaflets, etc.

Pilocarpus has not heretofore been reported from Mexico.

Triphasia trifoliata DC. Prodr. 1: 536. 1824.

Shrub 18 to 30 dm. high; flowers very fragrant; fruit red. In cultivation at Acapulco, February, 1895 (No. 467).

The plant is often used for hedges. The fruit is made into a kind of jelly.

Zanthoxylum arborescens Rose, sp. nov.

Small tree, 30 to 36 dm. high; branches with few short, scattered thorns; leaves large; leaflets 3 to 7, mostly 5, very variable, the larger ones 15 cm. long, oblong, tapering at base, the terminal leaflet more cuneate, slightly crenate, becoming glabrate above, puberulent beneath, especially on the veins; panicles open, terminal, puberulent (as well as young branches and rachis of leaves); calyx small; petals 5, reflexed, greenish-yellow; stamens 5, a little longer than the petals; styles 2; ovary 1-celled, 2-ovuled; seed 5 mm. long.

Collected by Dr. Edward Palmer along river banks and in arroyos, Ymala, August 16 to September 25, 1891 (No. 1454, immature fruit; No. 1455, in flower); and October 18, 1891 (No. 1405a, mature fruit).

A very distinct species and seemingly nearest the rare species *Z. melanostrictum*.

Zanthoxylum pterota (L.) H. B. K. Nov. Gen. & Sp. 6: 3. 1823. *Fagara pterota* L. Syst. ed. 10: 897. 1759?

Collected by Dr. Edward Palmer at Ymala, August 16 to 25, 1891 (No. 1424).

Zanthoxylum foetidum Rose, sp. nov.

Shrub 3 to 6 meters high; branches dark green and nearly glabrous; thorns plentiful, small, recurved and sharp; leaves compound; leaflets 3 to 5, lanceolate, petiolate, 2.5 to 6.2 cm. long, shortly acuminate, cuneate at base, crenate, puberulent on the veins beneath, thickly set with pellucid dots; panicles axillary, puberulent, many-flowered, 2.5 to 5 cm. long; sepals 4; petals 4; stamens with filaments longer than the petals; anthers ovate with a large gland at the tip; styles 2; fruit very glandular.

Collected by Mr. C. G. Pringle in barrancas above Cuernavaca, Morelos, altitude 1,808 meters, November 14, 1895 (No. 6207).

The leaves give forth a very offensive odor.

Near *Z. limoncello*, but distinct.

NOTES ON BURSERACEAE.

The genus Bursera up to 1883 was in a very confused condition. In this year appeared Dr. A. Engler's monograph of the genus,[1] in which 39 species are described. Since then, however, a number of new species have come to light in Mexico, of which the following is a list:

Bursera cerasifolia Brandegee, Proc. Cal. Acad. ser. 2, 3: 121. 1891.
Duplicate type in the National Herbarium.

Bursera fragilis Wats. Proc. Am. Acad. 21: 422. 1886.
Duplicate type (No. 72) in the National Herbarium.

Bursera glabrescens Rose, Contr. Nat. Herb. 3: 313. 1895. *Bursera palmeri glabrescens* Wats. Proc. Am. Acad. 25: 145. 1890.
Duplicate type (No. 77) in the National Herbarium.
This species may yet prove to be *B. jorullensis* (H. B. K.) Engler.

Bursera jonesii Rose, Contr. Nat. Herb. 3: 314. 1895.
Type (No. 491) in the National Herbarium.

Bursera aptera Ramirez, Anales Inst. Med. Nac. 2: 16. 1896.
Bursera trijuga Ramirez, Anales Inst. Med. Nac. 2: 16. 1896.
Bursera morelensis Ramirez, Anales Inst. Med. Nac. 2: 17. 1896.

Bursera laxiflora Wats. Proc. Am. Acad. 24: 44. 1889.
Duplicate type (No. 70) in the National Herbarium.

Bursera nelsoni Rose, Contr. Nat. Herb. 3: 314. 1895.
Type (No. 493) in the National Herbarium.

Bursera palmeri Wats. Proc. Am. Acad. 22: 402. 1887.
Duplicate type (No. 78) in the National Herbarium.

Bursera pringlei Wats. Proc. Am. Acad. 25: 145. 1890.
Duplicate type (No. 71) in the National Herbarium.

Bursera schaffneri Wats. Proc. Am. Acad. 22: 469. 1887.

Bursera tenuifolia Rose. Contr. Nat. Herb. 3: 314. 1895.
Type (No. 484) in the National Herbarium.

The following species have recently been acquired by the National Herbarium, one of which proves to be undescribed:

Bursera diversifolia Rose, sp. nov.

Tree 36 to 75 dm. high; older branches glabrous, shining, reddish; younger branches, rachis of leaves, and inflorescence pubescent; leaflets 4 to 6 pairs, the lower ones often again pinnate with 3 to 7 leaflets; the leaflets 25 mm. or less long, ovate or oblong, serrate, obtuse, rarely acute, rounded at base, or the terminal sometimes cuneate, pubescent and somewhat shining above, paler, softly pubescent and reticulated beneath; rachis between the leaflets narrowly winged; inflorescence contracted; fruit glabrous, 10 mm. long.

Collected by Mr. E. W. Nelson along road from Ocuilapa to Tuxtla, State of Chiapas, altitude 515 to 985 meters, August 29, 1895 (No. 3066).

This species seems nearest *B. submoniliformis*.

Bursera bicolor (Schlecht.) Engler in DC. Monogr. Phan. 4: 53. 1883. *Elaphrium bicolor* Schlecht. Linnaea, 17: 625. 1843.

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[1] In De Candolle, Monographiae Phanerogamarum, Vol. IV.

A shrub 45 to 60 dm. high. Collected by Mr. C. G. Pringle at Cuernavaca, 1896 (No. 6325).

Collected here also by Knechtel. It is new to the National Herbarium. I do not find that the height of the plant has been before mentioned.

Bursera galeottiana Engler in DC. Monogr. Phan. 4:47. 1883.

The leaflets were originally described as being 6 to 8 pairs. In the specimens before me some have only 6 pairs while others have from 12 to 14 pairs. The number of leaflets as in the closely related species *B. microphylla* is very variable. The nutlets are strongly 3-angled. Mr. Pringle says that this species is a small tree.

Collected by Rev. Lucius C. Smith on the hills at Milta, Oaxaca, altitude 1,969 meters, July 18, 1894 (No. 92); and by Mr. C. G. Pringle from Monte Alban near Oaxaca, Oaxaca, same altitude, November 27, 1894 (No. 6071).

This species was collected in Oaxaca by Galeotti at about the same altitude as Mr. Pringle's plant.

Bursera lanuginosa (H. B. K.) Engler in DC. Monogr. Phan. 4:58. 1883. *Elaphrium lanuginosum* H. B. K. Nov. Gen. & Sp. 7:31. 1825.

Much like *B. cuneata*, but with more numerous leaflets. "Curanavica" is the type locality of the species as given by Humboldt. The species has not since been reported.

Collected by Mr. C. G. Pringle on hillsides near Cuernavaca, Morelos, altitude 1,607 meters, November 9, 1895 (No. 6208).

Bursera ovalifolia (Schlecht.) Engler in DC. Monogr. Phan. 4: 40. 1883. *Elaphrium ovalifolium* Schlecht. Linnaea, 17: 248. 1843.

Collected by Dr. Edward Palmer near Acapulco, February, 1895 (No. 378). Without leaves, the determination very uncertain.

Bursera palmeri Wats. Proc. Am. Acad. 22: 402. 1887.

Collected by Dr. Edward Palmer near Acapulco, February, 1895 (No. 432).

Bursera submoniliformis Engler in DC. Monogr. Phan. 4: 55. 1883. *Elaphrium submoniliforme* Marchand; Engler, loc. cit., as synonym.

NOTES ON CUCURBITACEAE.

The Cucurbitaceae here reported are based upon the following collections: First, those of Mr. C. G. Pringle during his three trips to Mexico in 1894, 1895, and 1896; second, those of Dr. Edward Palmer in western Mexico, 1891 and 1892, and at Acapulco, 1894 and 1895; third, that of Mr. E. W. Nelson from 1894 to 1896; and fourth, that of Rev. Lucius C. Smith in the State of Oaxaca. I have also made reference to a number of specimens from other collectors as found in the collections at the Gray Herbarium, in those of John Donnell Smith and Mr. T. S. Brandegee, and in the National Herbarium.

ECHINOPEPON AND ITS ALLIES.

The genus Echinopepon appears to me to be perfectly distinct from Echinocystis proper. This was the view held by the late Dr. Sereno Watson. It is true that Prof. Alfred Cogniaux, our most eminent authority on this order, still retains Echinopepon as a subgenus; yet he now admits[1] that there is good reason for the separation. But even if Echinopepon is not restored, a strict application of the rules of priority will prevent the use of the name Echinocystis, this having been anticipated by that of Micrampelis, which has already been restored by a number of botanists.

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[1] Contr. Nat. Herb. 1: 100.

The genus Echinopepon was established in 1866 by Ch. Naudin,[1] who based it upon three till then undescribed species, viz, *E. milliflorus*, *E. quinquelobatus*, and *E. horridus*. In 1881 Professor Cogniaux, in his Monograph of the Cucurbitaceae, made Echinopepon and Megarrhiza sections of Echinocystis. This view has been generally accepted. Dr. Watson, however, in the Bulletin of the Torrey Botanical Club for 1887[2] contends that each deserves generic rank. A careful study in these groups extending over several years leads me to believe that these genera may be maintained on about the lines there laid down by Dr. Watson. By the removal of several outlying species which have been referred to Echinocystis either on account of poor material or for want of a better place, these genera can be more clearly defined. For the species cut off there have recently been established by Professor Cogniaux the new genera Vaseyanthus and Brandegea into which these abnormal forms seem very easily to fit.

A fourth section of Echinocystis called Pseudo-echinopepon was established by Professor Cogniaux in the Proceedings of the California Academy of Sciences[3], which also deserves generic rank, or rather should be merged into his recent genus Vaseyanthus. A short time before Dr. Watson established the section Heterosicyos in the genus Sicyos for a plant belonging to this same group. The species appears to me to belong to Brandegea rather than to Sicyos.

As I understand the group therefore the following genera are to be recognized:

ECHINOPEPON Naudin. *Echinocystis* § *Echinopepon* Cogn.
MARAH Kellogg. *Megarrhiza Torr.; Echinocystis* § *Marah* Cogn.
MICRAMPELIS Raf. *Echinocystis* Torr. & Gr.
VASEYANTHUS Cogn. *Echinocystis* § *Pseudo-echinopepon* Cogn.
BRANDEGEA Cogn. *Sicyos* § *Heterosicyos* Wats.

ECHINOPEPON.

I have examined specimens of the following species of Echinopepon all of which, except one, are to be found in the National Herbarium. I have seen additional material at the Gray Herbarium and have gone over John Donnell Smith's private collection.

Echinopepon cirrhopedunculatus Rose, Contr. Nat. Herb. 1:100, *pl. 4*. 1891.

Collected by Dr. Edward Palmer near Alamos, State of Sonora, September 16 to 30, 1890 (No. 634); also by Mr. C. G. Pringle at Tequila, State of Jalisco, October 3, 1893 (No. 4562).

The former specimen is the type (No. 220) of this species.

Echinopepon confusus Rose, sp. nov.

Stems slightly scabrous; leaves strongly 3-lobed to scarcely lobed, thin, acute, with broad open sinus; male flowers in long racemes (10 to 20 cm.), pedicels slender; corolla large (10 mm. wide), petals retuse, glabrous both within and without; female flowers nearly sessile; fruit oblong, 25 mm. long, with a slender beak; prickles short and stiff.

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[1] Ann. Sci. Nat. ser. 5, 6: 17.

[2] Bull. Torr. Club, 14: 158.

[3] Proc. Cal. Acad., ser. 2, 3: 59. 1890.

It differs from *E. wrightii* in its very long racemes, large male flowers which are not at all punctate-glandulose, and perhaps smaller fruit.

SPECIMENS EXAMINED IN GRAY HERBARIUM.

New Mexico:

Prinos Altos Mountains, September 16, 1890, E. L. Greene;

Copper Mines, October 11, 1891, Geo. Thurber (No. 1122); also a second specimen without data, also C. Wright's specimen from the Coppermine Creek, August, 1851, referred to *E. coulteri* in original description.

This species was also originally included by Dr. Gray in *Elaterium coulteri*, which species was based upon fruiting specimens collected by Coulter and flowering specimens of this species, which we now separate for the first time.

Certain specimens of this species have been confused with *E. wrightii.*

E. confusus and *E. wrightii* are the only two species of this genus found in the United States.

Echinopepon coulteri (Gray) Rose. *Elaterium? coulteri* Gray, Pl. Wright. 2:61. 1853. *Echinocystis coulteri* Cogn. Mem. Cour. Acad. Belg. 8vo, 28:88. 1878.

Collected by Mr. C. G. Pringle in the Sierra de San Felipe, Oaxaca, altitude 2,460 meters, October 5, 1894 (No. 4958).

These specimens answer better to the type of *E. coulteri* than any of the various specimens heretofore referred to it, and so far as I am aware it is really the first time the species has been re-collected.

The original description was based upon several specimens which appear to me to belong to two species. Those from the United States I have separated as above under the name of *E. confusus*. I have taken as the type of *E. coulteri*, Coulter's No. 51 from Zacatecas, Mexico, as this is the first plant mentioned in the description and the one which suggested the specific name. Professor Cogniaux has referred to *E. coulteri*, *E. horridus*, but a careful examination of considerable material has led me to separate the latter as below.

Echinopepon floribundus (Cogn.) Rose. *Echinocystis floribunda* Cogn. Mem. Cour. Acad. Belg. 8vo, 28:89. 1878.

Collected by Mr. E. W. Nelson in the valley of Oaxaca, altitude 1,607 to 1,705 meters. September 20, 1894 (No. 1272), and between Huajuapam, State of Oaxaca, and Reltazingo, State of Puebla, altitude 1,540 to 2,146 meters, November 19, 1894 (No. 1988); also from the same valley by Rev. Lucius C. Smith, October 8, 1894 (No. 217), and by Mr. C. G. Pringle in the valley of Oaxaca, State of Oaxaca, altitude 1,673 meters, September 22, 1894 (No. 4957).

Echinopepon horridus Naud. Ann. Sci. Nat. ser. 5, 6:19. 1866.

It seems to be best to keep this separate from *E. coulteri*, to which it has been referred by Professor Cogniaux; it differs especially in the shape and lobing of the leaves, the much larger and more spiny fruit, the punctate-glandular corolla, etc.

SPECIMENS EXAMINED.

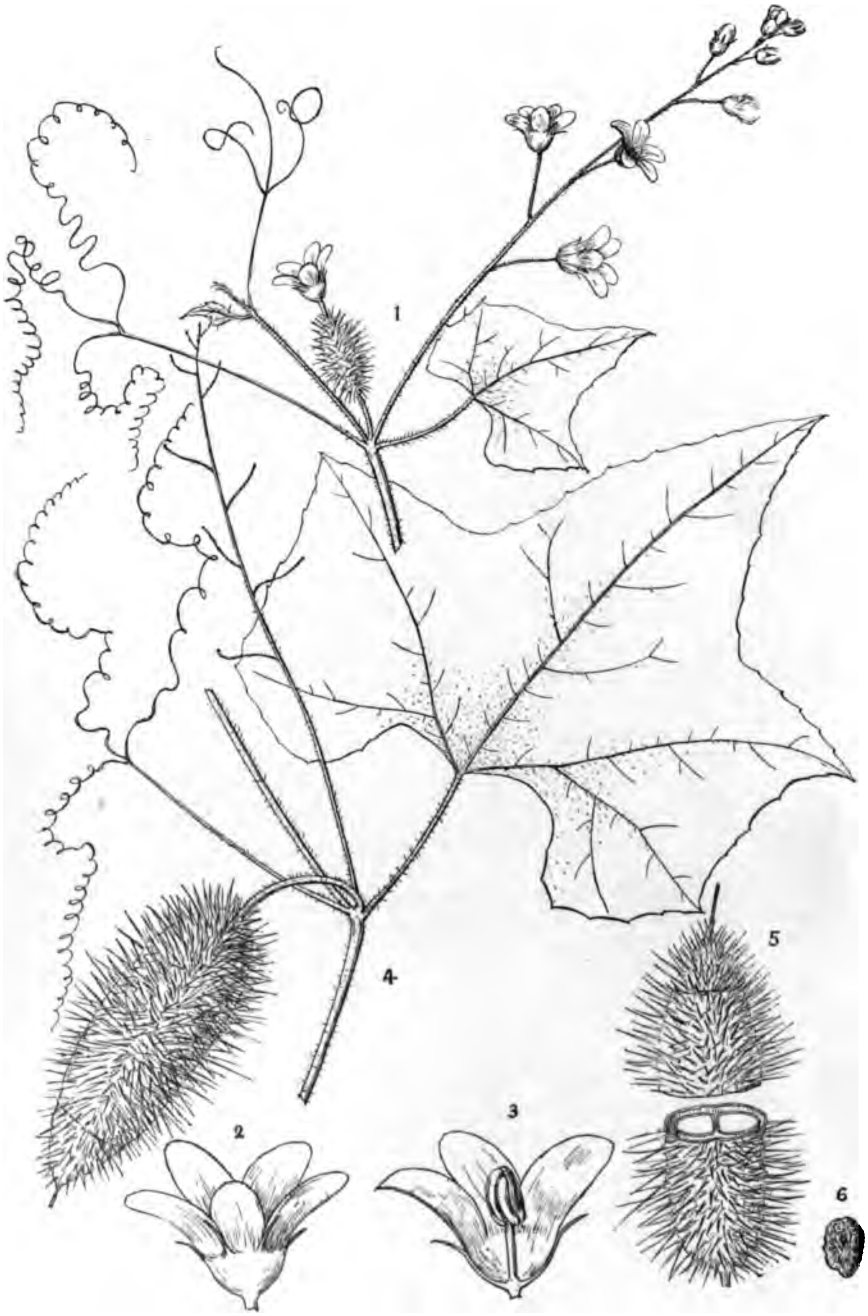
Central America:

Cartago, Prov. Cartago, Costa Rica, altitude 1,046 meters, *Juan J. Cooper*, November, 1887 (No. 5775).

Haie sur les bords du Rio Maria Aguilar, Costa Rica, altitude 1,135 meters, *Ad. Tonduz*, November 11, 1892 (No. 7177), and altitude 1,100 meters, December 29, 1892 (No. 7267). San Jose, Costa Rica, *H. Pittier*, November, 1889.

Coban Alta Paz, Guatemala, *H. von Turckheim*, December, 1886 (No. 1099).

Buena Vista, Depart. Santa Rosa, Guatemala, altitude 1,807 meters, *Heyde & Lux*, December, 1892 (No. 4188).



ECHINOPEPON PRINGLEI Rose.

Echinopepon jaliscanus Rose, sp. nov.

Stems climbing, grooved, pubescent; leaves rather thickish, pubescent, 3 to 5-lobed, the central lobe acuminate, with a broad open sinus at base; tendrils 3-parted; male flowers in racemes 15 to 25 cm. long, corolla rather large; female flowers nearly sessile, single, axillary, fruit nearly orbicular, 2 mm. long, tapering into a slender beak; prickles stout, slightly pubescent.

Collected by Mr. C. G. Pringle, at Tequila, State of Jalisco, September 30, 1894 (No. 4563), and distributed as *Echinocystis coulteri*.

Echinopepon lanatus (Cogn.) Rose. *Echinocystis lanata* Cogn. Mem. Cour. Acad. Belg. 8vo, 28:92. 1878.

Collected by Dr. Edward Palmer at Lodiego, October 9 to 15, 1891 (No. 1584). I am indebted to Prof. A. Cogniaux for the identification of this plant, but he refers it to Echinocystis.

I have recently seen a specimen collected by Mr. T. S. Brandegee in the Arroyo Hondo, Lower California, October 27, 1893. It has mature fruit which is 3 cm. thick. This is the largest-fruited species which I have seen.

Echinopepon minimus (Kellogg) Wats. Proc. Am. Acad. 24: 52. 1889. *Marah minima* Kellogg, Proc. Cal. Acad. 2: 18. 1863. *Elaterium minimum* Wats. Proc. Am. Acad. 12:252. 1877.

Collected by Dr. T. H. Streets on Cedros Island in 1876, and by Dr. Edward Palmer in March, 1889 (No. 719); also by T. S. Brandegee on Santa Margarita Island, Lower California, 1889; also by Dr. Palmer, La Paz, Lower California, January 20 to February 5, 1890 (No. 65).

Echinopepon longispina (Cogn.) Rose. *Echinocystis longispina* Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 92. 1878.

I have seen duplicates of the type in the Gray Herbarium. It was collected at Jorulla, Mexico, by Schiede, 1829 (No. 1080). It is characterized by the very long spines of the fruit, as the name would indicate, and by the peculiar inflorescence.

Echinopepon milleflorus Naud. Ann. Sci. Nat. ser. 5, 6:18. 1866. *Echinocystis milleflora* Cogn. Mem. Cour. Acad. Belg. 8vo, 28:88. 1878.

Collected by Mr. C. G. Pringle in the valley of Mexico, 1896 (Nos. 6467 and 6516). These two specimens show considerable difference in the foliage; the latter shows more variation from the type. The following characters may be noted: the leaves are reniform, not at all lobed, 6.2 cm. broad with a deep sinus, and on petioles 12.5 cm. or less long; the male racemes are sometimes 12.5 cm. or more long.

The above species is new to the National Herbarium, and until now has been known only from the original specimens of Bourgeau.

Echinopepon nelsoni Rose, sp. nov.

A low delicate vine, 6 to 9 dm. long; leaves small, 3-lobed, lateral lobes obtuse, central one acute and apiculate; male flowers in short racemes on peduncles longer than the leaves; corolla small, greenish white; female flowers on slender peduncles 18 to 25 mm. long; fruit narrow, covered with slender prickles and with the slender beak more or less prickly.

Collected by E. W. Nelson in the valley about Cuicatlan, State of Oaxaca, November 3, 1894 (No. 1878), and also near the same locality by V. Gonzales, December 18, 1895.

Echinopepon pringlei Rose, sp. nov. PLATE IV.

High-climbing vine; stem sulcate, pubescent; blade of leaf broadly ovate in outline, very variable in size, 5 to 10 cm. long, 3.7 to 12.5 cm. broad, more or less 3-lobed, the middle lobe triangular, acuminate, the lateral ones broader, somewhat rounded, often again lobed, apiculate, remotely serrate, more or less hispid on both sides; sinus broad, somewhat rectangular; petiole 12 to 50 mm. long, covered with stiff, straight hairs; tendrils 2 or 3-parted; male flowers in simple elongated racemes; racemes much longer than the leaves, 10 to 17.5 cm. long, many-flowered; pedicels slender, 10 mm. long; calyx greenish, 4 mm. broad, 3 mm. high, pubescent; sepals filiform, one-fourth the length of the tube; corolla white, 10 mm. broad; lobes short and obtuse; stamens conduplicate; female flowers solitary; peduncles 6 to 18 mm. long, 3.7 to 5 cm. long, 18 mm. broad, thickly covered with slender prickles; prickles more or less pubescent; beak slender, tardily breaking away, seeds 10, black.

Collected by Mr. C. G. Pringle in a barranca near Cuernavaca, Morelos, Mexico, 5,000 feet altitude, November 8, 1895 (No. 6183).

EXPLANATION OF PLATE.—Fig. 1, flowering branch; fig. 2, male flower; fig. 3, a longitudinal section of the same; fig. 4, a fruiting branch; fig. 5, fruit; fig. 6, seed; scale of all ⅔.

Echinopepon pubescens (Benth.) Rose. *Elaterium pubescens* Benth. Pl. Hartw. 6. 1839. *Echinocystis pubescens* Cogn. Mem. Cour. Acad. Belg. 8vo, 28:88. 1878.

Collected by Mr. C. G. Pringle on volcanic hills, Monte Leon, State of Michoacan, November 11, 1892 (No. 4346).

Echinopepon parvifolius Rose, sp. nov.

Stems slender; leaves 5-lobed, more or less scabrous, male flowers in slender racemes, 6 mm. wide, the lobes of the corolla ovate, acute; fruit oblong, small, prickly even to the apex.

Collected by C. Conzatti, Huitzo, Oaxaca, October 1, 1895 (No. 139).

Here perhaps belongs Bourgeau's No. 789, which, however, was referred by Professor Cogniaux to *E. wrightii.*

Echinopepon torquatus (DC.) Rose. *Elaterium torquatum* DC. Prodr. 3: 310. 1828. *Echinocystis torquata* Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 90. 1878. *Echinopepon quinquelobatus* Naud. Ann. Sci. Nat. ser. 5, 6: 18. 1866.

Collected by Mr. T. S. Brandegee in Lower California at Sierra San Lazaro, September 17, 1893, and La Mesa, October 24, 1893.

I have seen no Mexican material for this species and these specimens may not belong here; but they do not belong with any other described Echinopepon. Cogniaux has also referred here a plant from the Rio Magdalena (Lower California), which is probably the same as ours. The leaves, however, are larger and the peduncles much longer than described; the leaves are sometimes over 12 cm. long on petioles 7.5 cm. long.

Echinopepon wrightii (Gray) Wats. Bull. Torr. Club, 13:158. 1887. *Elaterium wrightii* Gray, Pl. Wright. 2: 61. 1853. *Echinocystis wrightii* Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 88. 1878.

The type (No. 222) is in the National Herbarium and is C. Wright's No. 1090 from mountains at Guadalupe Pass.

SPECIMENS EXAMINED IN GRAY HERBARIUM.

New Mexico:
- Mountains at Guadalupe Pass, *C. Wright*, 1851 (No. 1090).

Arizona:
- Cienega, *J. T. Rothrock*, August, 1894 (No. 581).
- Santa Catalina Mountains, altitude 2,624 meters, *J. G. Lemmon*, April, 1880 (No. 45).

Mexico:
- Magdalena, Sonora, October, 1851, *Geo. Thurber* (No. 951).
- Los Esqueros, Sonora, altitude 1,575 meters, October 13, 1890, *C. V. Hartman* (No. 168).
- Acapulco, October, 1894 to March, 1895, *Dr. Edward Palmer* (No. 13).

This species has been confused in our herbaria with a very different species from New Mexico which was included by Dr. Gray under *Elaterium coulteri*, but which I have separated as above.

The corolla is punctate-glandular within, not "sprinkled with adherent pollen grains," as originally described.

The following species ascribed to Echinocystis probably belong in Echinopepon, but I only know them from descriptions and therefore leave them in the old genus:

Echinocystis glutinosa Cogn.
Echinocystis gemella Cogn.
Echinocystis muricata Cogn.
Echinocystis polycarpa Cogn.
Echinocystis araneosa Griseb.
Echinocystis paniculata Cogn.

The following species referred to Echinopepon and Echinocystis § Echinopepon are to be excluded from Echinopepon:

Echinopepon bigelovii Wats. = *Brandegea* sp.
Echinopepon palmeri Wats. = *Brandegea* sp.
Echinopepon insularis Wats. = *Vaseyanthus* sp.
Echinopepon parviflorus Wats. = *Brandegea* sp.

VASEYANTHUS.

The genus Vaseyanthus was first described by Professor Cogniaux,[1] and was based upon a single species, *V. rosei*. Previously, however, Professor Cogniaux had described an Echinocystis under the name *E. brandegei*, for which he constructed the separate section Pseudo-echinopepon. This species belongs more properly in the genus Vaseyanthus, and I have no hesitancy in referring it there. I fear, however, it is too near *V. rosei*, and have little doubt but it will eventually be combined with it.

There is still another somewhat anomalous species that I should refer here, viz, *Echinopepon insularis* Wats.

This species, while more like Echinopepon than either of the above, still differs from it in some important particulars.

The transfer of these two species to Vaseyanthus will make Echinopepon a more consistent genus.

The genus Vaseyanthus has a small globose fruit covered with short, stiff spines, capped with a cone-shaped caducous beak; its walls are very thick; it has a single cell with two ovules and mostly one seed. The genus is confined to Lower California and the adjacent islands. The species with synonomy and collections may be brought together as follows:

Vaseyanthus rosei Cogn. Zoe, 1: 368, *t. 11.* 1891.

Collected by Dr. E. Palmer near La Paz, Lower California, January 20 to February 5, 1890 (No. 102) and at Carmen Island, November 1 to 7, 1890 (No. 837).

The former specimen is the type (No. 560) and is deposited in the National Herbarium.

Vaseyanthus brandegei (Cogn.) Rose. *Echinocystis brandegei* Cogn. Proc. Cal. Acad. ser. 2, 3: 59. 1890.

Collected by T. S. Brandegee, La Paz, Lower California, November 1, 1890. Duplicate specimens of the type (No. 705) are deposited in the National Herbarium.

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[1] Zoe, 1: 368.

Vaseyanthus insularis, (Wats.) Rose. *Echinopepon insularis* Wats. Proc. Am. Acad. 24: 51. 1889.

Only known from Dr. Edward Palmer's specimen (No. 409) from San Pedro Martir Island, Lower California, 1887. A duplicate specimen of the type (No. 347) is deposited in the National Herbarium.

BRANDEGEA.

The genus Brandegea was established by Professor Cogniaux in 1890, and was based upon two species from different genera. One of them, *B. bigelovii*, has long been a puzzle, having previously been referred to 4 different genera. The genus, while apparently a valid one, should be made to include a number of outlying species which have been assigned to several genera.

As I understand the genus the following species may be recognized:

Brandegea bigelovii (Wats.) Cogn. Proc. Cal. Acad. ser. 2, 3: 58. 1890. *Elaterium bigelovii* Wats. Proc. Am. Acad. 12: 252. 1877. *Echinocystis bigelovii* Cogn. in DC. Monogr. Phan. 3: 804. 1881. *Echinopepon bigelovii* Wats. Proc. Am. Acad. 24: 52. 1889.

The only United States specimens are from the valley of the Lower Colorado, where they were collected by Dr. E. Palmer and J. M. Bigelow. We have a specimen of Dr. Palmer's plant (type No. 257) in the National Herbarium.

The species has been collected in Lower California by Brandegee at Soledad (January 8, 1890) and San Gregorio (February 7, 1889).

In the Botany of California this species was referred to *Melothria pendula* L.; afterwards Dr. Watson separated it as a new species of Elaterium, and later he referred it to Echinopepon. Professor Cogniaux first referred it to Echinocystis, but afterwards made it the type of this genus.

Brandegea monosperma, (Brandegee) Cogn. Proc. Cal. Acad. ser. 2, 3: 59. 1890. *Cyclanthera monosperma* Brandegee, Proc. Cal. Acad. ser. 2, 2: 159. 1889.

Collected by T. S. Brandegee at Agua Dulce, Lower California in 1889 and perhaps also by Palmer at La Paz in 1890 (No. 144).

Brandegea palmeri (Wats.) Rose. *Echinopepon palmeri* Wats. Proc. Am. Acad. 24: 52. 1889.

Only known from original specimens collected by Dr. E. Palmer near Guaymas, Mexico, 1887 (No. 304).

Duplicate type specimens (No. 346) are deposited in the National Herbarium.

Brandegea parviflora Wats. *Echinocystis parviflora* Wats. Proc. Am. Acad. 17: 373. 1882. *Echinopepon parviflora* Wats. Proc. Am. Acad. 24: 52. 1889.

Said to have been collected by W. G. Wright "in the San Bernardino Mountains, California," in 1880, but not since collected. I have seen the type in the Gray Herbarium.

After I had made the above change in manuscript my attention was called by Mr. Samuel Parish to the occurrence of the combination *Brandegea parviflora* with the authority "Watson, in herb." in Patterson's checklist. Though there a nomen nudum, the name should be retained with Watson as author. I had examined the type at Cambridge but had found no reference to Mr. Watson's transfer. The citation should have been Watson "in lit." rather than "in herb."

The above quotation regarding the type locality is from Mr. Watson. In regard to this as well as time of collection Mr. Parish has kindly furnished the following note:

> I collected the cucurbit you ask me about in April, 1879, I rather think in company with Mr. Wright, at any rate at the same place. It—the station—is wrongly given by Dr. Watson (Proc. Amer. Acad. 17: 373) as "San Bernardino Mountains."

Mr. Wright and I both collected it in West Canyon, on the Eastern or Desert base of the San Jacinto Mountains, near Palm Springs, then called Agua Caliente. It was not seen in any of the other canyons of the neighborhood. The single specimen I then collected is still in my herbarium. The plant has a large Megarrhiza-like root, and it grows in sheltered places among rocks.

Last spring I revisited Palm Springs, and one of my principal objects was to collect again this rarity. A very careful search, however, failed to discover a trace of it. The canyon in which it grew is a short one, and as well as I can remember the plant was not very abundant, but I can hardly account for its apparent extinction at the type station. No doubt it may be found, sometime, in the little-explored region of its growth.

Brandegea minimus (Wats.) Rose. *Sicyos minimus* Wats. Proc. Am. Acad. 23: 274. 1888.

Collected by Mr. C. G. Pringle in the Sierra Madre, State of Chihuahua, October, 1887 (No. 1876), October 2, 1888 (No. 1871). Dr. Watson constructed a special section (Heterosicyos) for the species, but it appears to be congeneric with the above.

SPECIES OF OTHER GENERA.

Apodanthera pringlei Wats. Proc. Am. Acad. 25: 149. 1890.

Collected by Mr. E. W. Nelson near Huajuapan, State of Oaxaca, altitude 1,840 to 2,146 meters, November 16, 1894 (No. 1974).

Apodanthera roseana Cogn. Contr. Nat. Herb. 3: 317. 1893.

Collected by Dr. Edward Palmer near Ymala, August 16 to 25, 1891 (No. 1444).

Cayaponia dubia (Hook. & Arn.) Rose. *Anguria dubia* Hook. & Arn. Bot. Beech. Voy. 292. 1839-40. *Bryonia attenuata* Hook. & Arn. Bot. Beech. Voy. 424. 1841. *Trianosperma attenuata* Hemsl. Biol. Cent. Amer. 1: 486. 1880. *Cayaponia attenuata* Cogn. in DC. Monogr. 3: 769. 1881.

Collected by Dr. Edward Palmer near Acapulco, March, 1895 (Nos. 499, 503). The type of *Bryonia attenuata*, was collected by Sinclair at Acapulco.

Corallocarpus emetocatharticus (Grosourdy) Cogn. Bull. Soc. Bot. Belg. 30, pt. 1: 279. 1891. *Doyerea emetocathartica* Grosourdy, El Medico Bot. criollo, 2: 388. 1864.

Low-climbing vine, but specimen without leaves or fruit.

Collected by Dr. Edward Palmer near Acapulco, March, 1896 (No. 558).

The material which we have of this species is very poor and I am indebted to Prof. A. Cogniaux of Verviers, Belgium, for its determination.

I have since seen specimens collected by C. G. Pringle on limestone ledges, Las Palmas, State of San Luis Potosi, April 27, 1891, altitude 1,470 meters (No. 5763).

Cucurbita foetidissima H. B. K. Nov. Gen. & Sp. 2: 123. 1817.

Collected by Mr. E. W. Nelson, but exact locality not given (No. 3886); also by Dr. Edward Palmer near Durango, June, 1896 (No. 248).

Cucurbita radicans Naud. Ann. Sci. Nat. ser. 5, 6: 8. 1866.

A low-climbing plant.

An elegant species with flowers 10 cm. in diameter, the fruit small, nearly spherical, 7.5 cm. long. This wild gourd is called "chicoyote." The seeds are used in making a cooling drink.

Collected by Dr. Edward Palmer near Acapulco, December, 1894 (No. 183). Also obtained by Dr. Palmer at Culiacan, October 25 to November 18, 1891 (No. 1802), but with somewhat smaller flowers. This latter specimen was determined by Professor Cogniaux.

Cyclanthera eremocarpa (Schauer) Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 74. 1878. *Sicyos eremocarpa* Schauer, Linnaea, 20: 722. 1847.

I have seen no named specimens of this species, and my identification may be wrong.

Collected by Mr. C. G. Pringle, 1896 (No. 6535).

Cyclanthera langaei Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 65. 1878.

Collected by Mr. C. G. Pringle in wet canyons, Sierra de San Felipe, Oaxaca, altitude 2,952 meters, November 21, 1894 (No. 6047); also by Mr. E. W. Nelson near San Cristobal, altitude 2,296 to 2,567 meters, September 18, 1895 (Nos. 3133, 3137, 3159, 3231).

Cyclanthera micrantha Cogn. Contr. Nat. Herb. 3: 318. 1895.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1706).

The type (No. 486) is in the National Herbarium.

Cyclanthera ribiflora (Schlecht.) Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 63. 1878.
Elaterium ribiflorum Schlecht. Linnaea, 7: 388. 1832.

Collected by Mr. C. G. Pringle on river banks near Orizaba, Vera Cruz, altitude 1,312 meters, January 18, 1895 (No. 6090).

Cyclanthera pringlei Robinson & Seaton, Proc. Am. Acad. 28: 106. 1893.

Collected by Mr. C. G. Pringle, 1896 (No. 6534).

We have a duplicate type (No. 302) of this species in the National Herbarium.

Elaterium ciliatum Cogn. Mem. Cour. Acad. Belg. 8vo, 28: 54. 1878.

Collected by Mr. E. W. Nelson near Tuxtla, State of Chiapas, altitude 790 to 921 meters, September 1, 1895 (No. 3099.)

This species has not before been reported from Mexico.

Elaterium longisepalum Cogn. Contr. Nat. Herb. 3: 318. 1895.

Collected by Dr. Edward Palmer at Lodiego, October 9 to 15, 1891 (No. 1600).

The type (No. 442) is in the National Herbarium.

Luffa operculata (L.) Cogn. in Mart. Fl. Bras. 6, pt. 4: 12. 1878. *Momordica operculata* L. Syst. ed. 10: 1278. 1758–59.

Collected by Dr. Edward Palmer near Acapulco, March, 1895. No. 548.

Luffa operculata intermedia Cogn. Contr. Nat. Herb. 1: 330. 1895.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1686).

This plant was determined by Professor Cogniaux.

Melothria donnell-smithii Cogn. Bot. Gaz. 21: 9. 1891.

Collected by Dr. Edward Palmer at Lodiego, October 9 to 15, 1891 (No. 1604).

This plant was determined by Professor Cogniaux.

Melothria scabra Naud. Ann. Sci. Nat. ser. 5, 6: 10. 1866.

Collected by Dr. Edward Palmer near Acapulco, March, 1895 (No. 557).

Microsechium helleri (Peyr.) Cogn. in DC. Monogr. Phan. 3: 910. 1881. *Sicyos helleri* Peyr. Linnaea, 30: 56. 1856.

Collected by Mr. E. W. Nelson in the vicinity of Cerro San Felipe, altitude 3,117 to 3,620 meters, 1894 (No. 1059).

Momordica zeylanica Mill. Dict. ed. 8: no. 3. 1768. *Momordica charantia abbreviata* Ser. in DC. Prodr. 3: 311. 1828.

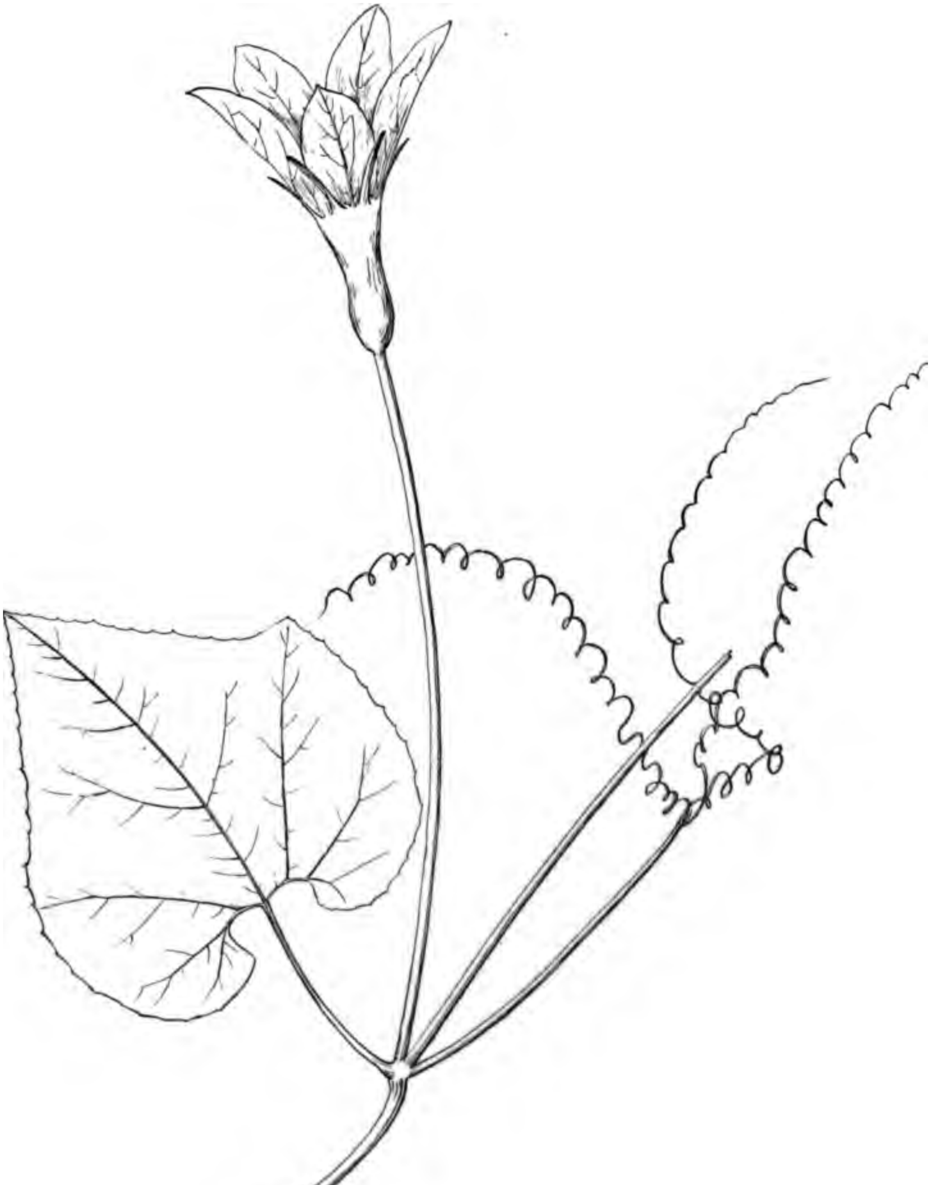
A low-climbing plant, at least in cultivation; stem angled, puberulent; leaves deeply 3-lobed, crenate; the lateral lobes again lobed; the base with broad open sinus; blade somewhat puberulent; flowers solitary; peduncles with minute bracts (a line or two long).

Collected by Dr. Edward Palmer near Acapulco, Mexico, March, 1895 (No. 555); also by Dr. Palmer at Culiacan, August 27 to September 15, 1891 (No. 1522).

This plant is the same as Wright's No. 1206 from Mazatlan, Mexico, which is referred as *M. charantia abbreviata* by Dr. B. L. Robinson.

The plant appears to me to be quite distinct from *Momordica charantia*, from which it differs in the shape and much smaller size of the fruit, and in the smaller leaves and bracts as also in the seeds.

This form has a wide range, being reported from many places in the Old World. The only stations known in Mexico are the three named above.



PITTIERA PARVIFOLIA Rose.

MISCELLANEOUS GENERA AND SPECIES.

PITTIERA.

The genus Pittiera, only recently (1891) established by Prof. A. Cogniaux, now contains four species, two of which appear here for the first time. Of three of these species we have specimens in the National Herbarium, one of them being a type, the other two duplicate types.

The following species is now first described:

Pittiera parvifolia Cogn. & Rose. PLATE V.

Foliis parvis, breviuscule petiolatis, tenuiter membranaceis, ovato-cordatis, indivisis, utrinque laevibus, primum brevissime puberulis demum glabratis; calyce brevissime et densiuscule glanduloso-puberulo, tubo anguste cylindrico superne satis dilatato, lobis lineari-subulatis tubo multo brevioribus; corollae segmentis obovato-oblongis, acutis; staminum filamentis basi paucipilosis.

Rami gracillimi elongati, sulcati, juniores petioli pedunculi cirrhique subtiliter puberuli. Petiolus gracilis, 2 cm. longus. Folia laete viridia, margine spinuloso-denticulata, 2½–4 cm. longa, 2–3½ cm. lata; nervi laterales basilares trifurcati, imum sinum marginantes. Cirrhi robustiusculi, sulcati, 4–5-fidi. Pedunculus masculus satis gracilis, 11 cm. longus. Calycis tubus 18–19 mm. longus, ad medium 3–4 mm. et ad apicem circiter 1 cm. latus; lobi erecto-patuli, 6–7 mm. longi, 1 mm. lati. Corolla tenuiter puberula, 22 mm. longa. Staminum filamenta filiformia, 12 mm. longa; capitulum antherarum oblongum, 10–11 mm. longum, 4 mm. crassum. Flores feminei et fructus ignoti.

Guatemala: E. W. Nelson, No. 3532.

EXPLANATION OF PLATE.—A flowering branch; scale ⅔.

The following note has been kindly furnished me by Professor Cogniaux:

On doit aussi rapporter aux Pittiera le *Cayaponia grandiflora* Cogniaux; d'ou il resulte que ce genre se compose actuellement des quatre especes suivantes:

1. **Pittiera grandiflora** Cogn. *Cayaponia grandiflora* Cogn. in DC. Monogr. Phan. 3:779. 1881.

Folia paulo latiora quam longa, indivisa, membranacea, pubescenti-scabra; calycis lobi tubo satis breviores; corollae segmenta oblonga, obtusa; staminum filamenta basi dense villosa.—Yucatan; Guatemala ad Rio Samalá prov. Retalhuleu (Shannon n. 270).

2. **Pittiera parvifolia** Cogn. & Rose, *supra*.

[Type in the National Herbarium.]

3. **Pittiera longipedunculata** Cogn. Bull. Soc. Bot. Belg. 30, pt. 1:272. 1891.

Folia fere aequilata quam longa, indivisa, tenuiter membranacea, scabra; calycis lobi tubo aequilongi vel vix breviores; corollae segmenta ovata, acuta; staminum filamenta basi pilosula.—Costa Rica.

[Duplicate type (No. 215) in the National Herbarium.]

4. **Pittiera trilobata** Cogn. Bot. Gaz. 20:289. 1895.

Folia paulo longiora quam lata, plus minusve trilobata, rigidiuscula, pubescenti-scabra; calycis lobi tubo longiores; corollae segmenta obovato-oblonga, acuta; staminum filamenta basi pilosula.—Guatemala.

[Duplicate type (No. 245) in the National Herbarium.]

SCHIZOCARPUM.

The genus Schizocarpum is restricted to Mexico and Central America. Only a single species is recorded in the Biologia Centrali-Americana. The genus is now represented by the six following species, one of them here first described:

Schizocarpum guatemalense Cogn. Bot. Gaz. 20:290. 1895.

We have a duplicate type of this species.

Schizocarpum palmeri Cogn. & Rose, Contr. Nat. Herb. 1:100. 1891.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1693). These specimens contain mature fruit and show that it is really 3-celled and not 2-celled as originally described.

We have the type of this species.

Schizocarpum liebmannii Cogn. in DC. Monogr. Phan. 3:553. 1881.

Schizocarpum filiforme Schrad. Linnaea, 6, Lit. Ber.:73. 1831.

This rare species has recently been collected by Rev. Lucius C. Smith on the Rancho de Calderon, San Juan del Estado, altitude 1,545 meters, November 4, 1894 (No. 302); also by Mr. E. W. Nelson in the vicinity of La Parada, altitude 2,460 to 2,797 meters, August 19, 1894 (No. 998); also by Mr. C. G. Pringle on dry bluffs, Sierra de San Felipe, Oaxaca, altitude 2,303 meters, October 11, 1894 (No. 4,980).

Schizocarpum parviflorum Robinson & Greenman, Proc. Am. Acad. 29: 386. 1894.

We have a duplicate type of this species.

Schizocarpum attenuatum Cogn. & Rose, sp. nov. PLATE VI.

A low-climbing plant; younger branches angled, pubescent and with a few scattering stiff hairs; leaves ovate with a broad open sinus, 3-lobed, obtuse, denticulate, puberulent above and beneath, flowers axillary, solitary; pedicels of the male flower 37 mm. long, female 8 to 16 mm. long; sepals minute, filiform; corolla yellow, about 5 cm. long, with a cylindrical tube and long, attenuate lobes; stamens 3; fruit 3-angled, 3 to 6 cm. long, tapering at base, attenuate above into a slender beak; puberulent, 3-celled, each cell divided into 2 rows of 2 to 3 secondary cells, each 1-seeded; seeds flattened, somewhat spatulate, 8 to 10 mm. long, banded crosswise by light and dark stripes.

Collected by Dr. Edward Palmer at Acapulco, October, 1894 (No. 12).

This well-marked species differs from others of this genus in the attenuate lobes of the corolla.

Type in the National Herbarium.

EXPLANATION OF PLATE.—Fig. 1, flowering branch; fig. 2, fruiting branch; fig. 3. fruit with outer covering removed; scale ⅔.

All these species are rare in collections, but it will be seen from the above that the National Herbarium contains five of the six, four of which are types.

SPECIES OF OTHER GENERA.

Roseanthus albiflorus Cogn. Contr. Nat. Herb. 3: 578, *t. 28*. 1896.

The type of this species is in the National Herbarium. The seed came from Acapulco, where it was collected by Dr. Edward Palmer in 1895.

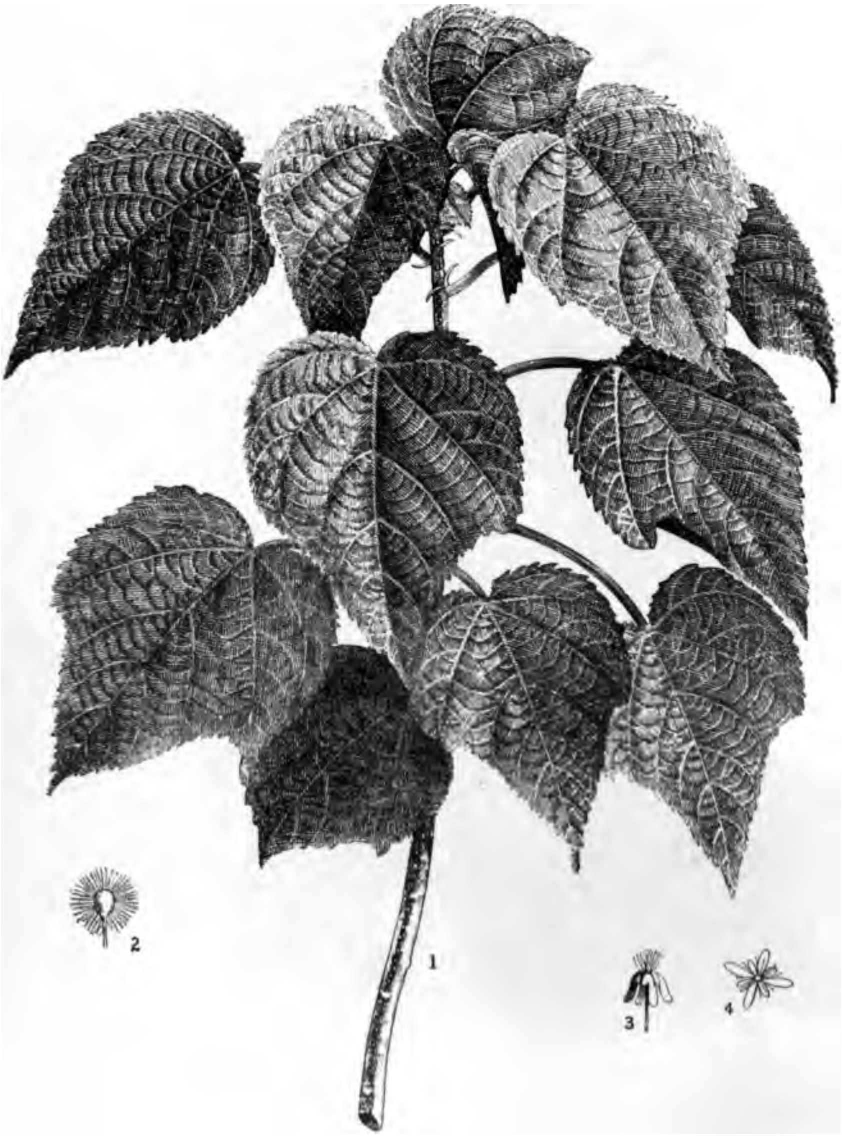
Sicyos angulata L. Sp. Pl. 2:1013. 1753.

Collected by Mr. E. W. Nelson near San Cristobal, State of Chiapas, altitude 2,303 to 2,893 meters, September 18, 1895 (No. 3148).

Sicyos echinocystoides Cogn. Contr. Nat. Herb. 3:319. 1895.

Collected by Dr. Edward Palmer at Tepic, January 5 to February 6, 1892 (No. 1894).

The type (No. 478) is in the National Herbarium.



HELIOCARPUS AMERICANUS L.

A SYNOPSIS OF THE SPECIES OF HELIOCARPUS.

The genus Heliocarpus has been variously described as having from 1 to 5 species. Hemsley listed 7 species in the Biologia, but two of them are without specific name. Bentham & Hooker state that there are 4 species; Durand says there are 4 or 1, while Dr. Schumann, who has recently studied this genus for Engler & Prantl and had previously elaborated it for the Flora Brasiliensis accepts but a single species. My own study leads me to think that there are from 15 to 20 species. This number includes 6 species described here for the first time and 3 recent species described by Dr. Watson, all largely based on material not seen by others. In my enumeration I have recognized all the species heretofore published, although 1 or 2 of them are uncertain and may properly belong to synonomy. For instance I have seen no plant which seems to answer quite to *H. trichopodus*. I can easily make out all the Mexican species, but there is still some confusion in the Central and South American. The type of the genus is *H. americanus*, one of the rarest species of all, although much material has been referred to it. I have not attempted to treat this genus exhaustively here but more as suggesting needed study.

The genus is divided nearly equally into two groups by the presence of a stipe or its approximate or entire absence.

* *Stipe present, elongated and somewhat bristly.*

+ *Leaves not appendaged at base.*

++ *Sepals unappendaged at tip.*

1. **Heliocarpus americanus** L. Sp. Pl. 1: 448. 1753. PLATE VII.

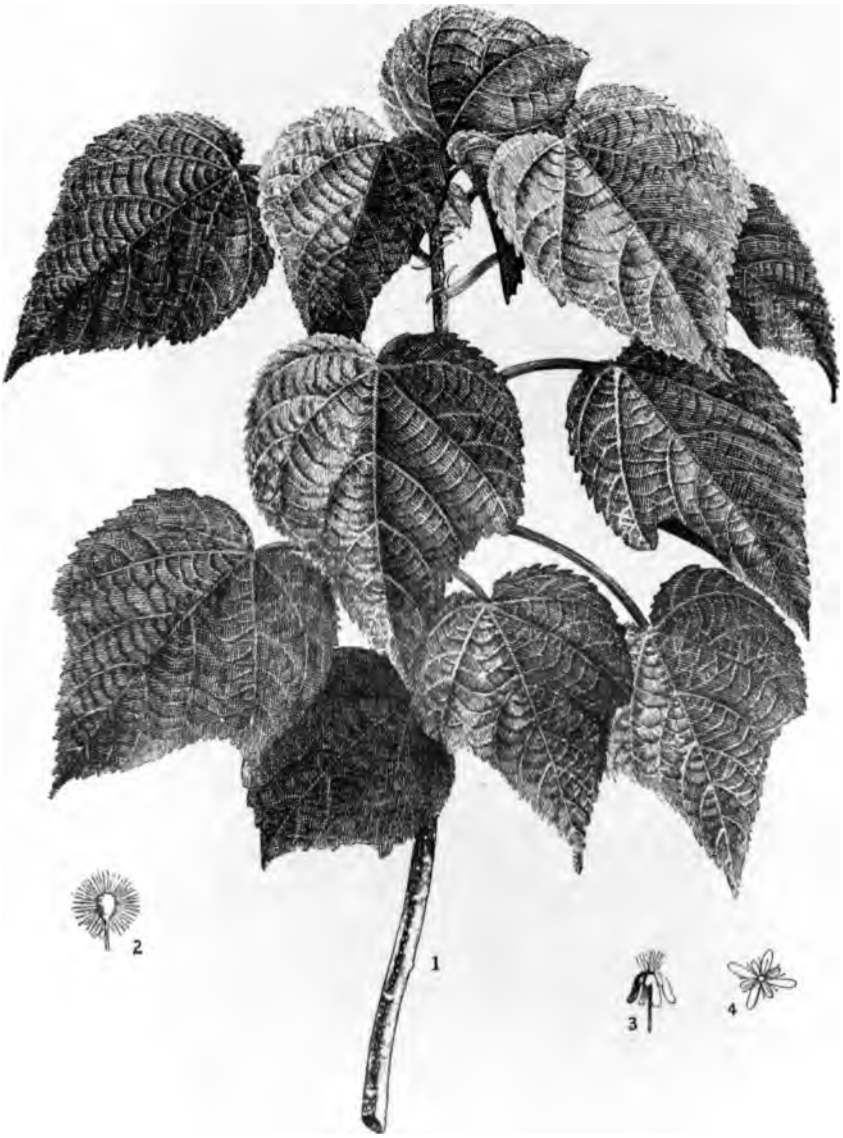
This species was based upon plate 16 of *Hortus Cliffortianus*. The only plant which I have seen in any of our American herbaria which at all approaches it is A. Fendler's No. 1277 B (in Herb. Gray) from Venezuela (1854–5).

Prof. Schumann states that the species was described from specimens grown from seed sent from Mexico, although Linnaeus' figure and description does not seem to answer any plant which we have seen from that country. Linnaeus says the plant is from the warmer parts of America, but does not state its habitat more definitely. I have here reproduced from *Hortus Cliffortianus* the plate upon which *H. Americanus* is based.

EXPLANATION OF PLATE.—Fig. 1, leafy branch; fig. 2, fruit; figs. 3, 4, flower; scale about ⅔ that of original plate, where the flower is natural size.

2. **Heliocarpus popayanensis** H. B. K. Nov. Gen. & Sp. 5: 341. 1821. *H. americanus popayanensis* Schum. in Mart. Fl. Bras. 12, pt. 3: 142. 1886.

I have not seen the type of this species, which comes from Popayan, U. S. of Colombia, but Miguel Bang's Bolivia plant (No. 1491) has been distributed under this name and answers the description fairly well. It may be characterized as follows: Leaves large, the lower ones cordate at base, the smaller ones sometimes rounded at base, dark green and somewhat stellate above, very pale and densely stellate beneath; inflorescence very much spreading, branching dichotomously, densely pubescent with both simple and stellate hairs; flowers in dense nodose clusters on very short pedicels; sepals 4, 4 mm. long, conspicuous, densely pubescent without, glabrous and nerved within; petals small; stamens 16 (in type "18–22"); ovary stipitate; fruit small, the body about 4 mm. in diameter, the marginal plumose hairs about the same length, the sides with short and slender hairs; stipe short for the section, 4 mm. long.



HELIOCARPUS AMERICANUS L.

Cyclanthera langaei Cogn. Mem. Cour. Acad. Belg. 8vo, 28:65. 1878.

Collected by Mr. C. G. Pringle in wet canyons, Sierra de San Felipe, Oaxaca, altitude 2,952 meters, November 21, 1894 (No. 6047); also by Mr. E. W. Nelson near San Cristobal, altitude 2,296 to 2,567 meters, September 18, 1895 (Nos. 3133, 3137, 3159, 3231).

Cyclanthera micrantha Cogn. Contr. Nat. Herb. 3:318. 1895.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1706).

The type (No. 486) is in the National Herbarium.

Cyclanthera ribiflora (Schlecht.) Cogn. Mem. Cour. Acad. Belg. 8vo, 28:63. 1878. *Elaterium ribiflorum* Schlecht. Linnaea, 7:388. 1832.

Collected by Mr. C. G. Pringle on river banks near Orizaba, Vera Cruz, altitude 1,312 meters, January 18, 1895 (No. 6090).

Cyclanthera pringlei Robinson & Seaton, Proc. Am. Acad. 28:106. 1893.

Collected by Mr. C. G. Pringle, 1896 (No. 6534).

We have a duplicate type (No. 302) of this species in the National Herbarium.

Elaterium ciliatum Cogn. Mem. Cour. Acad. Belg. 8vo, 28:54. 1878.

Collected by Mr. E. W. Nelson near Tuxtla, State of Chiapas, altitude 790 to 921 meters, September 1, 1895 (No. 3099.)

This species has not before been reported from Mexico.

Elaterium longisepalum Cogn. Contr. Nat. Herb. 3:318. 1895.

Collected by Dr. Edward Palmer at Lodiego, October 9 to 15, 1891 (No. 1600).

The type (No. 442) is in the National Herbarium.

Luffa operculata (L.) Cogn. in Mart. Fl. Bras. 6, pt. 4:12. 1878. *Momordica operculata* L. Syst. ed. 10:1278. 1758–59.

Collected by Dr. Edward Palmer near Acapulco, March, 1895. No. 548.

Luffa operculata intermedia Cogn. Contr. Nat. Herb. 1:330. 1895.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1686).

This plant was determined by Professor Cogniaux.

Melothria donnell-smithii Cogn. Bot. Gaz. 21:9. 1891.

Collected by Dr. Edward Palmer at Lodiego, October 9 to 15, 1891 (No. 1604).

This plant was determined by Professor Cogniaux.

Melothria scabra Naud. Ann. Sci. Nat. ser. 5, 6:10. 1866.

Collected by Dr. Edward Palmer near Acapulco, March, 1895 (No. 557).

Microsechium helleri (Peyr.) Cogn. in DC. Monogr. Phan. 3:910. 1881. *Sicyos helleri* Peyr. Linnaea, 30:56. 1856.

Collected by Mr. E. W. Nelson in the vicinity of Cerro San Felipe, altitude 3,117 to 3,620 meters, 1894 (No. 1059).

Momordica zeylanica Mill. Dict. ed. 8: no. 3. 1768. *Momordica charantia abbreviata* Ser. in DC. Prodr. 3:311. 1828.

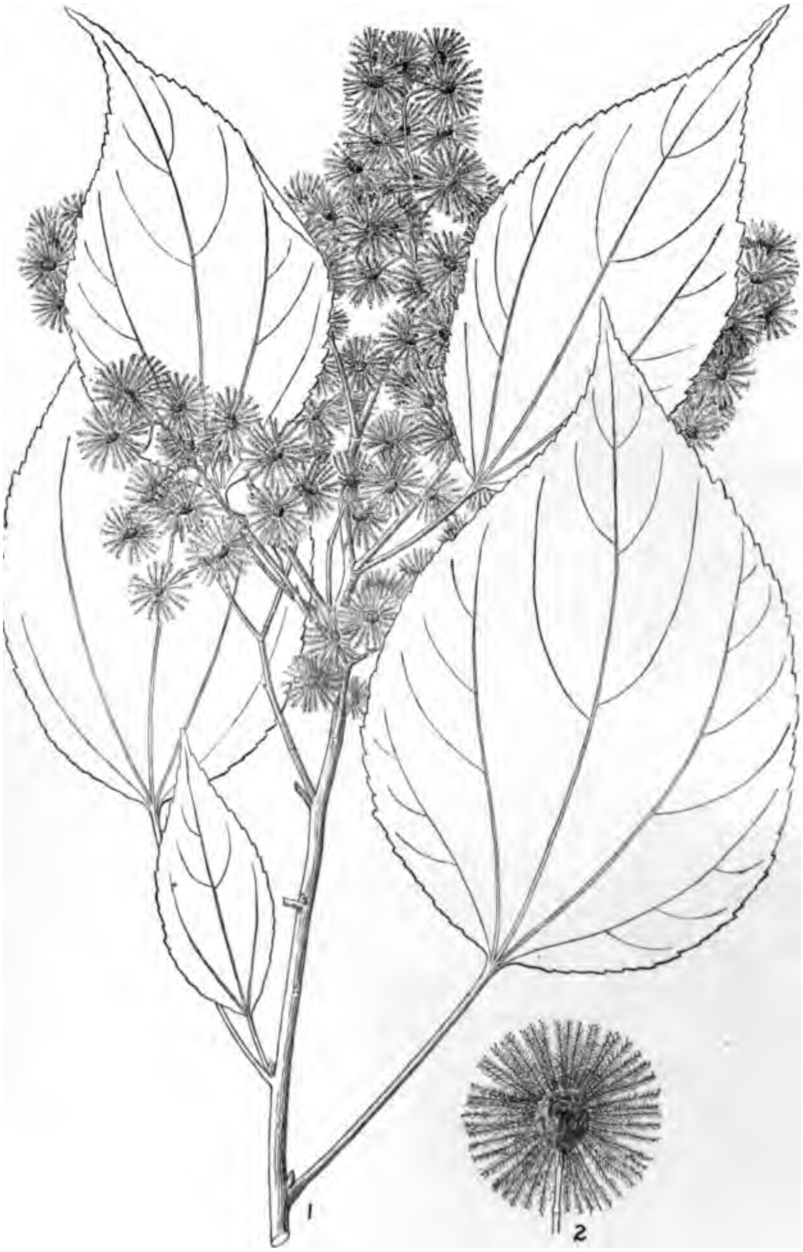
A low-climbing plant, at least in cultivation; stem angled, puberulent; leaves deeply 3-lobed, crenate; the lateral lobes again lobed; the base with broad open sinus; blade somewhat puberulent; flowers solitary; peduncles with minute bracts (a line or two long).

Collected by Dr. Edward Palmer near Acapulco, Mexico, March, 1895 (No. 555); also by Dr. Palmer at Culiacan, August 27 to September 15, 1891 (No. 1522).

This plant is the same as Wright's No. 1206 from Mazatlan, Mexico, which is referred as *M. charantia abbreviata* by Dr. B. L. Robinson.

The plant appears to me to be quite distinct from *Momordica charantia*, from which it differs in the shape and much smaller size of the fruit, and in the smaller leaves and bracts as also in the seeds.

This form has a wide range, being reported from many places in the Old World. The only stations known in Mexico are the three named above.



HELIOCARPUS OCCIDENTALIS Rose

reddish stellate pubescence beneath; leaves rather thickish and strongly veined beneath; fruit globose, pubescent on the sides.

The only specimen of this species which bears this name is Capt. John Donnell Smith's (No. 1723) from Guatemala, thus distributed by him. It answers fairly well the description and comes from a point not far from the type locality. This species has heretofore only been known from the State of Tabasco, Mexico, where it was obtained by Linden.

. Here also I would refer the specimen collected by Ad. Tonduz in Talemania, Costa Rica, in March, 1894 (No. 8561).

* * *Stipe very short or wanting.*

+ *Fruit oblong.*

9. **Heliocarpus glanduliferus** Robinson in herb.

A tree; stems slightly hairy, more or less densely clothed with reddish glands; leaves ovate to ovate-oblong, entire, rounded or slightly cordate at base, acute or acuminate, densely and softly stellate beneath, darker and slightly pubescent above, serrate, the lower teeth especially glandular; inflorescence a small panicle with the pedicels or branches in nodose clusters; buds oblong, constricted at base, with appendages at tip very prominent and spreading; sepals 5, linear, 6 mm. long, appendaged near the tip; petals shorter than the sepals; stamens about 40; fruit sessile, oblong, the body 6 to 7 mm. long, the margin fringed with plumose hairs, the sides wrinkled and nearly glabrous.

Collected by Sutton Hayes in mountains near Santa Maria, Guatemala, November, 1860, and since collected in the same country by Messrs. Heyde and Lux in 1892 near Chupadero, altitude 5,000 feet, and distributed by Capt. John Donnell Smith under No. 3956; also by Mr. E. W. Nelson near Yajalon, State of Chiapas, November 21, 1891 (No. 3400); and by Ad. Tonduz, Rio Torres, S. Francisco de Guadalupe, Prov. S. Jose, Costa Rica, altitude 1,000 meters, December, 1893 (No. 8453). While this last plant is one of the numbers upon which *H. polyandrus nodiflorus* Donnell Smith[1] is based, it is clearly distinct from the other number as well as from the species *H. polyandrus*.

In *H. glanduliferus* the pubescence of the branches is composed mostly if not entirely of simple, somewhat crisped, hairs. The upper surface of the leaves has somewhat similar hairs, but often 2, sometimes 3 to 4-branched at base; the upper surface only a little darker than the lower, those of the branches always rounded at base and rarely if ever oblique. In all the above points, besides in its very characteristic fruit, it differs from *H. nodiflorus*.

Type in Herb. Gray and in National Herbarium.

+ + *Fruit orbicular.*

++ *Leaves becoming nearly glabrate, scarcely if at all paler beneath, mostly rounded at base.*

10. **Heliocarpus occidentalis** Rose, sp. nov. PLATE VIII.

A small tree 4.5 to 9 meters high, the trunk 7.5 to 12.5 cm. in diameter; leaves lanceolate to broadly ovate, rounded at base, palmately 5 to 7-nerved, long-acuminate, somewhat regularly serrate, with obtuse teeth, thin, green and somewhat roughened but becoming glabrate above; paler, more strongly veined, and somewhat stellate beneath; flowers unknown; inflorescence a large spreading panicle; pedicels 4 to 6 mm. long, jointed and breaking off near the base, with short stellate pubescence; stipe none; fruit 12 to 14 mm. long, including the fringe of plumose hairs; the body orbicular, 3 mm. in diameter, with rugose surface and slightly stellate.

Collected by Dr. E. Palmer at Acapulco, Mexico, December 1 to 31, 1890 (No. 440), and at Manzanillo, Mexico (No. 986).

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[1] Bot. Gaz. 23:240. 1897.

Referred in Contributions from the National Herbarium, vol. 1, p. 310, to *H. tomentosus*.

Type in U. S. National Herbarium.

EXPLANATION OF PLATE.—Fig. 1, fruiting panicle with leaves, scale $\frac{2}{3}$; fig. 2, fruit, scale $1\frac{1}{3}$.

++ ++ *Leaves densely stellate-pubescent, especially below.*

= *Sepals not appendaged.*

11. **Heliocarpus nelsoni** Rose, sp. nov.

A shrub 2.4 to 6 meters high; young parts scurfy-pubescent; leaves broadly ovate, somewhat 3-lobed, slightly cordate at base, long-acuminate, irregularly serrate, densely almost velvety-pubescent, densely stellate above, 10 to 15 cm. long, 7.5 to 10 cm. broad; inflorescence a compact leafy panicle; buds purplish; sepals 4 or 5, oblong, 4 mm. long, not appendaged at tip; fruit almost equally covered with plumose hairs; stipe none.

This species is similar to *H. reticulatus*, but has the leaves less reticulated, sepals not appendaged, etc.

Collected by E. W. Nelson on the dry hills in the Valley of Oaxaca, September 8, 1894 (No. 1243); also in the foot hills on the west side of the Valley of Oaxaca, September 20, 1894 (No. 1485); also collected near Cuernavaca by Berlandier, October 20, 1827 (No. 1064), and near the same locality by Bourgeau in 1865–66 (No. 1200). The latter number is referred to in the Biologia by Mr. Hemsley under Heliocarpus, but without specific name.

Type in United States National Herbarium.

= = *Sepals appendaged.*

a. *Leaves strongly reticulated beneath.*

12. **Heliocarpus reticulatus** Rose, sp. nov. PLATE IX.

A small tree; younger branches, leaves, and inflorescence densely stellate-pubescent; leaves broadly ovate, more or less 3-lobed, cordate at base, acuminate, somewhat irregularly serrate, strongly reticulated beneath, 7.5 to 15 cm. long, 5 to 10 cm. wide on petioles, 2.5 to 5 cm. long; inflorescence an open terminal panicle, but in fruit very compact; sepals 5, linear, 4 to 6 mm. long, with a small appendage near the apex; petals small, 2 mm. long; stamens about 20; fruit 10 mm. in diameter, including the fringe of plumose hairs, the sides with similar but short hairs; stipe wanting.

Collected by Mr. C. G. Pringle on the hills near Guadalajara, State of Jalisco, in November and December, 1888 (No. 1791), and distributed as *H. americanus* var.

This species resembles very much *H. americanus* in the shape of the leaves, but is very unlike it in its fruit, etc.

Type in United States National Herbarium.

EXPLANATION OF PLATE.—Fig. 1, flowering panicle with leaves, scale $\frac{2}{3}$; fig. 2, fruit; fig. 3, seed; figs. 2 and 3, scale $1\frac{1}{3}$.

aa. *Leaves not strongly reticulated beneath.*

b. *Shrubs, leaves stellate on both sides.*

c. *Fringe of fruit shorter and stouter than in the next, stamens 20, leaves broad.*

13. **Heliocarpus palmeri** Wats. Proc. Am. Acad. 21: 420. 1886.

Only known from type collection.

Type in Gray Herbarium. Duplicate type (No. 1226) in U. S. National Herbarium.

cc. *Fringe of fruit of slender bristles; stamens 16; leaves ovate, narrower than in the last.*

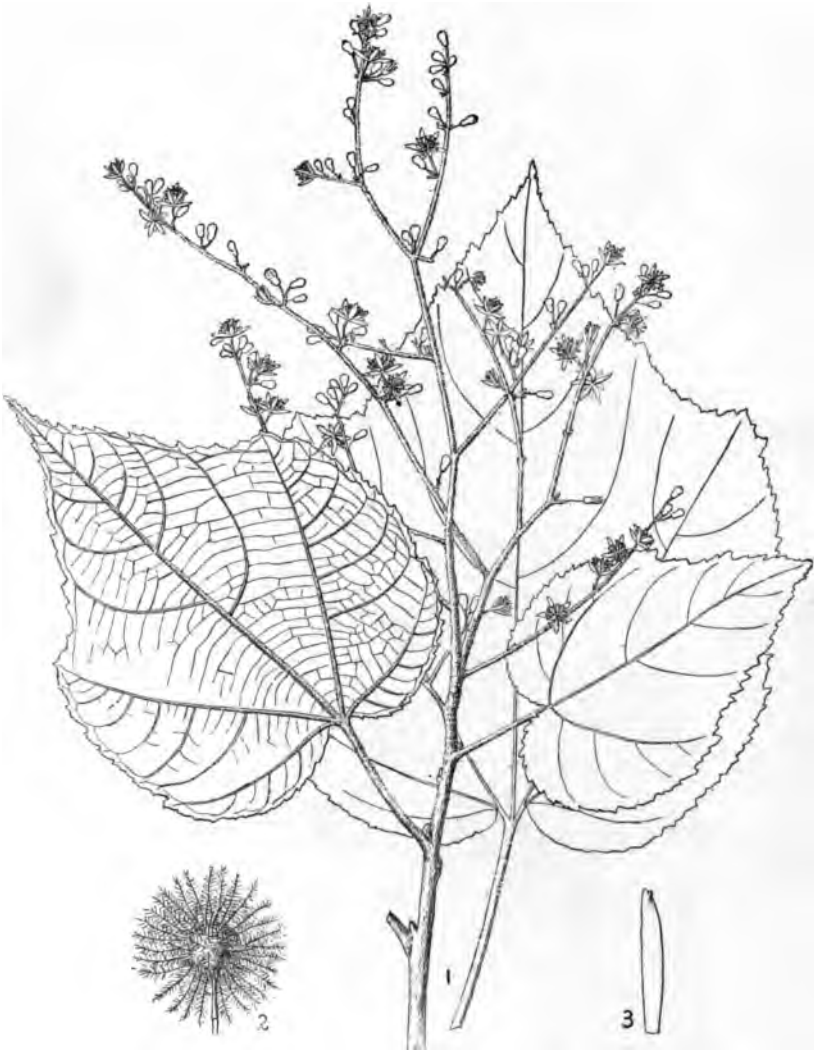
14. **Heliocarpus attenuata** Wats. Proc. Am. Acad. 21: 420. 1886.

Type in Gray Herbarium, duplicate type (No. 1225) in U. S. National Herbarium.

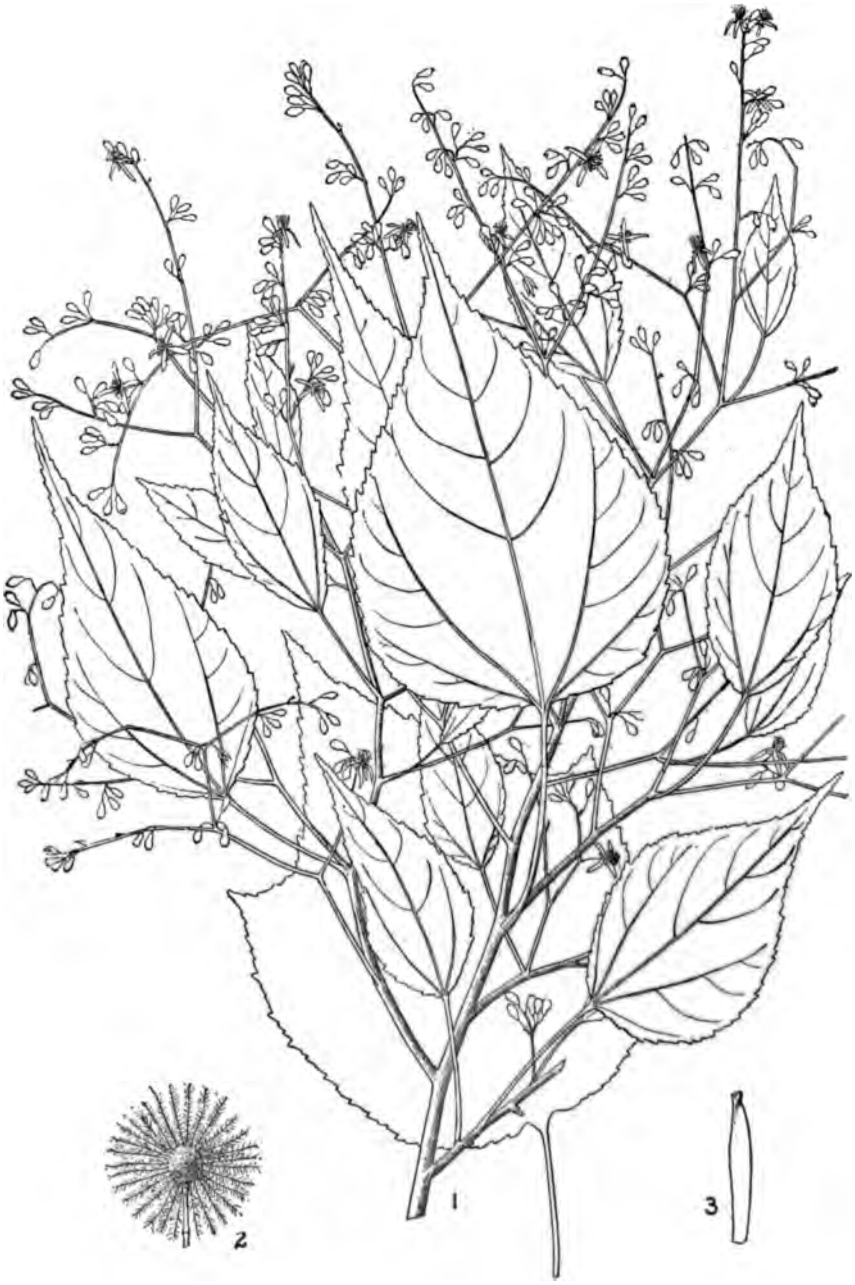
bb. *Small trees: leaves nearly glabrate above, beneath with a pale close tomentum.*

15. **Heliocarpus pallidus** Rose, sp. nov. PLATE X.

Tree 3.6 to 7.5 meters high; young branches clothed with dense stellate hairs; leaves simple or 3-lobed, more or less broadly ovate, 5 to 7.5 cm. long, the petiole 2.5



HELIOCARPUS RETICULATUS Rose.



HELIOCARPUS PALLIDUS Rose

to 5 cm. long, long-acuminate, mostly rounded at base, dark green and becoming nearly glabrous above, very pale and covered with dense close tomentum beneath, palmately 3 to 5-veined, somewhat irregularly serrate; inflorescence an open spreading panicle; buds club-shaped, densely stellate; sepals 4, linear, 6 mm. long, with a small appendage near the apex; petals 4, minute, 2 mm. long; stamens about 20; stipe none; fruit 10 mm. in diameter, including the fringe of plumose hairs; the body orbicular, 2 mm. in diameter, densely stellate, and with a few scattered plumose hairs.

Collected by Dr. E. Palmer near Acapulco, 1894 (No. 157); also by Mr. E. W. Nelson between Copala and Juchitango, Guerrero, February 9, 1895 (No. 2298).

EXPLANATION OF PLATE.—Fig. 1, flowering panicle with leaves, scale ⅔; fig. 2, fruit; fig. 3, seed; figs. 2 and 3, scale 1½.

A SYNOPSIS OF THE SPECIES OF WIMMERIA.

The genus was established in 1831, two species, *W. concolor* and *W. discolor*, being described. It was monographed by Radlkofer in 1878, and the two species of Schlechtendal were increased to six. The *W. confusa* of Hemsley and the very recent species *W. cyclocarpa* bring the number up to eight. Of these eight species seven are Mexican. Until 1885 the genus was entirely unrepresented in the National Herbarium. We now lack but one of the Mexican species, this one of the original ones, *W. discolor*. The collections of Pringle, Palmer, and Nelson have just added three of the rarest species to our collection.

The following key to the Mexican and Central American species, taken largely from Radlkofer, will be found useful in disentangling herbarium specimens:

§ ENDALOPHUS: *fruit longer than broad, ovate-oblong, narrowly winged.*

Wimmeria concolor Schlecht. Linnaea, 6:428. 1831.

This species is represented in the National Herbarium by Mr. Pringle's No. 3706 from San Luis Potosi (1891).

Wimmeria discolor Schlecht. Linnaea, 6:428. 1831.

I do not know this species. It must be near the above. The type was collected at Papantla, State of Vera Cruz.

§ ENDOLOPHUS: *fruit shorter than broad, suborbicular, broadly winged.*

* *Leaves pubescent.*

+ *Leaves large, thin, serrulate.*

Wimmeria cyclocarpa Radlk. Bot. Gaz. 18:199. 1893.

We have duplicates of the type which were distributed by Capt. John Donnell Smith.

+ + *Leaves small, thickish.*

++ *Blade of leaf glabrous or becoming glabrate but with the petiole (as are the peduncles and young branches) puberulent, crenate; anthers obtuse.*

Wimmeria confusa Hemsl. Diag. Pl. Nov. fasc. 1: 6. 1878.

This species is represented in the National Herbarium by the following specimens: Dr. Palmer's Nos. 261 and 262 from southwestern Chihuahua (1885); No. 368 from Jalisco (1886); No. 648 from Alamos (1890), and No. 1598 from Lodiego (1891).

++ ++ *Blade of leaf pubescent on both sides, entire or serrulate, smaller than the last; anthers apiculate.*

Wimmeria pubescens Radlk. Sitzb. Math. Phys. Akad. Muench. 8: 378. 1878.

Shrub 2.1 to 3 meters high; anthers broadly ovate, shortly acuminate.

Collected by Mr. C. G. Pringle on calcareous hills, Tehuacan, State of Puebla, 1895 (No. 6289); and by Mr. E. W. Nelson near Nenton, Guatemala, altitude 912 meters, December 13, 1895 (No. 3522). This species has only been known before from the specimens of Liebmann from Consoquitla. Mr. Nelson obtained excellent fruiting specimens which answer the description except that the leaves are not quite so long. On the other hand Mr. Pringle's plants, which are only in flower, have the longer leaves, but none of them are obovate. I have little hesitancy, however, in referring both specimens as above. The species is new to the National Herbarium.

* * *Leaves large, glabrous.*

+ *Leaves with lateral nerves indistinct, obtuse, scarcely serrate.*

Wimmeria pallida Radlk. in part.

A spreading shrub 24 dm. high; leaves lanceolate, obtuse, with slender cuneate base, 5 to 8.7 cm. long, 2.5 to 5 cm. broad, petioles slender; fruit broader than long, 20 to 30 mm. broad.

Collected by Dr. Edward Palmer near Acapulco, November, 1894 (No. 124). *Wimmeria confusa* was so called because it had been confused with *W. concolor* and so figured in Hooker's Icones. It was named in 1878 by Mr. Hemsley, who based it upon Hartweg's plant; the same year Radlkofer described his *W. pallida*, basing it in part upon Hartweg's specimens as figured in Hooker's Icones, but also referring it to specimens collected by Haenke (perhaps at Acapulco) and Liebmann. In the Biologia this species is referred to *W. confusa* and the confusion continued. Palmer's specimens I think belong to a different species from Hartweg's and I propose to retain for them Radlkofer's name of *W. pallida*. The two species as thus separated are very distinct both in fruit and foliage.

+ + *Leaves with lateral nerves more prominent, long-petioled, finely and regularly serrate.*

Wimmeria persifolia Radlk. Sitzb. Math. Phys. Akad. Muench. 8: 379. 1878.

Shrub 4.6 meters high.

Collected by Mr. C. G. Pringle at Cuernavaca, 1895 (No. 6210). This species, like the above, is only known from Liebmann's collection. It was collected at Ejutla, State of Oaxaca.

The above specimen seems properly referred, although the fruit is not so large as described. The species is new to the National Herbarium.

A SYNOPSIS OF THE AMERICAN SPECIES OF HERMANNIA.

The genus Hermannia in the first volume of the Biologia Centrali-Americana is represented by a single species (*H. texana*). The rare *H. inflata*, redescribed below, was overlooked, while two other species have recently been described. The genus is a large one, but is almost wholly South African. The four species here referred to are the only ones known on the American continent.

The following key will be of aid in determining our American material.

* *Calyx much inflated.*

Hermannia inflata Link & Otto, Ic. Pl. Rev. 55, t. 28. 1828.

This species has been rare in collections and was entirely wanting in the National Herbarium—in fact its publication has been overlooked by many. Dr. Gray thought it was simply a manuscript name. Mr. Hemsley omitted it from the first volume of the Biologia Centrali-Americana, while the writer was at first inclined to consider Mr Nelson's plant a new species. My specimens may be described as follows:

Shrub, 12 to 18 dm. high; branches densely stellate-tomentose; leaves ovate, 3.7 cm. or less long, obtuse, with broad cuneate base, 3.7 cm. long; petioles short; stip-

ules linear-lanceolate; flowers in leafy racemes, on short peduncles: calyx inflated, strongly veined, purplish, 3 lines high with broadly ovate lobes; petals 5, distinct, purple, nearly orbicular, tapering at base into a slender claw with strongly incurved margins; stamens 5, opposite the petals; filaments broad with ciliate margins; anther cells ciliate with acuminate tips; styles 5, distinct; carpels densely stellate, but the crest not armed; cells 5, each 5-seeded.

Collected by Mr. E. W. Nelson, on dry hills in the valley of Oaxaca, September 8, 1894 (No. 1216); also by Mr. C. G. Pringle on limestone ledges of Monte Alban, altitude 1,906 meters, 1894 (No. 4798); also by Thomas Coulter near Zimapan (No. 802). The latter two specimens were seen in the Gray Herbarium.

* * *Calyx not inflated.*

+- ***Petals reflexed or spreading; stamens wholly exserted, filaments nearly wanting, anthers elongated and connivent; crest of carpels armed with long, glochidiate spines.***

Hermannia palmeri Vasey & Rose, Contr. Nat. Herb. 1: 67. 1890.

SPECIMENS EXAMINED.

Lower **California:**
La Paz, Dr. Edward Palmer, January 20, February 5, 1890 (No. 29);
Todos Santos, T. S. Brandegee, January 22, 1890.

The type specimens of this species are in the National Herbarium.

+-+- ***Petals at most spreading; stamens not wholly exserted; filaments distinct, anthers short, not connivent; crest of carpels not armed with long, glochidiate spines.***

++ ***Flowers yellow,*** *minute; crest of carpels dentate or with very short spines.*

Hermannia pauciflora Wats. Proc. Am. Acad. 17: 368. 1882.

SPECIMENS EXAMINED.

Mexico:
Guaymas, *Dr. Edward Palmer,* 1887 (No. 227);
Arizona:
Santa Catalina Mountains, *C. G. Pringle,* April 11, 1881 (No. 344);
Sierra Tucson, *C. G. Pringle,* April 28, 1884;
South side of Santa Catalina Mountains, *J. G. Lemmon,* August, 1883 (No. 3669).

++ ++ ***Flowers yellow,*** *twice the size of the last; crest of carpels lined with rather pectinate bristles.*

Hermannia texana Gray, Gen. Illustr. 2: 88, *t. 135.* 1849.

SPECIMENS EXAMINED.

Mexico:
Nuevo Leon, Monterey, *C. G. Pringle,* June, 1888 (No. 1926);
Monterey, *Chas. K. Dodge,* May 1891 (No. 135);
Coahuila and Nuevo Leon, *Dr. Edward Palmer,* February to October, 1880 (No. 113).
New Mexico:
———, *C. Wright,* 1851 (No. 902).
Texas:
———, *F. Lindheimer,* 1846 (Nos. 356 & 357) and 1847 (No. 585);
Valley of the Rio Grande, *J. M. Bigelow* (No. 119);
Canyon of Sabinal, *J. Reverchon,* June (No. 108);
Pena, Duval County, *G. C. Nealley,* 1889 (No. 3916);
Western part, *C. Wright,* October, 1849 (No. 67).

A SYNOPSIS OF DRYMARIA NODOSA AND ITS ALLIES.

Two of our thin, linear-leaved species of Drymaria, *D. nodosa* and *D. tenella,* have been more or less confused in our collections. My study of the group in the light of recent collections and a comparison of both types seems to warrant the separation from each of at least one species. My understanding of these four species is expressed in the following key, to which I have added a list of the various specimens examined. The collections studied were the Gray and National herbaria.

* *Stems not glabrous; sepals lanceolate; acuminate, strongly 3-nerved; capsule much shorter than the calyx.*

+ *Stems glandular-pubescent; petals longer than sepals; leaves narrow-channeled; of more northern range.*

Drymaria nodosa Engelm. Pl. Fendl. 12. 1849.

SPECIMENS EXAMINED.

Mexico:

State of Chihuahua, near Chihuahua, *C. G. Pringle* (No. 581) October, 1885, and (No. 716) October 15, 1886; also base of Sierra Madre (No. 1195), September 20, 1897; also at Cosiquiriachi, *Dr. Wislizenus*, June and July.

State of Sonora, Los Pinitos, *C. V. Hartman* (No. 138), October, 1890.

++ *Stems pubescent, rarely if ever glandular; often glabrate; petals shorter than the sepals; leaves flat; of different habit and more southern range.*

Drymaria gracillima (Hemsl.) Rose; *D. nodosa* (?) *gracillima* Hemsl. Diag. Pl. Nov. 2:22. 1879.

Although this form seems to be separable as a species from *D. nodosa*, I should state that no two botanists have seemed to agree as to its position. Dr. Gray, who first published upon it, says:

> From this [*D. nodosa*] No. 697 of Coulter's Mexican collection scarcely differs except that the plant is less diffuse, the leaves nearly flat, the alar pedicels shorter, and the petals smaller,—differences which are likely to arise from station.

Englemann, who described a number of species in this genus besides *D. nodosa*, considered it a good species, naming it after T. Coulter, although his name was never published. He says of it:

> A small annual a few inches high, nearly related to *D. nodosa* but well distinguished by the erect growth, by the shorter flat linear (or almost linear-lanceolate) leaves, short pedicels, and inclosed petals.

Mr. Hemsley has followed an intermediate course, describing it as a variety of *D. nodosa*.

SPECIMENS EXAMINED.

Mexico:

State of San Luis Potosi, *Parry & Palmer* (No. 60), 1878, type; *Dr. J. G. Schaffner* (No. 140), 1876, at least in part and No. 5 at least in part.

Real del Monte, Sierra de Aguseo, altitude 2,500 meters, in gravelly soil, *T. Coulter* (No. 697);

Locality not given, *C. G. Pringle*, September 8, 1896 (No. 6482).

State of Durango, Durango, *Dr. Edward Palmer*, April to November, 1896 (No. 912).

* * *Stems glabrous; sepals ovate, obtuse, not strongly 3-nerved; capsule scarcely shorter or longer than the calyx.*

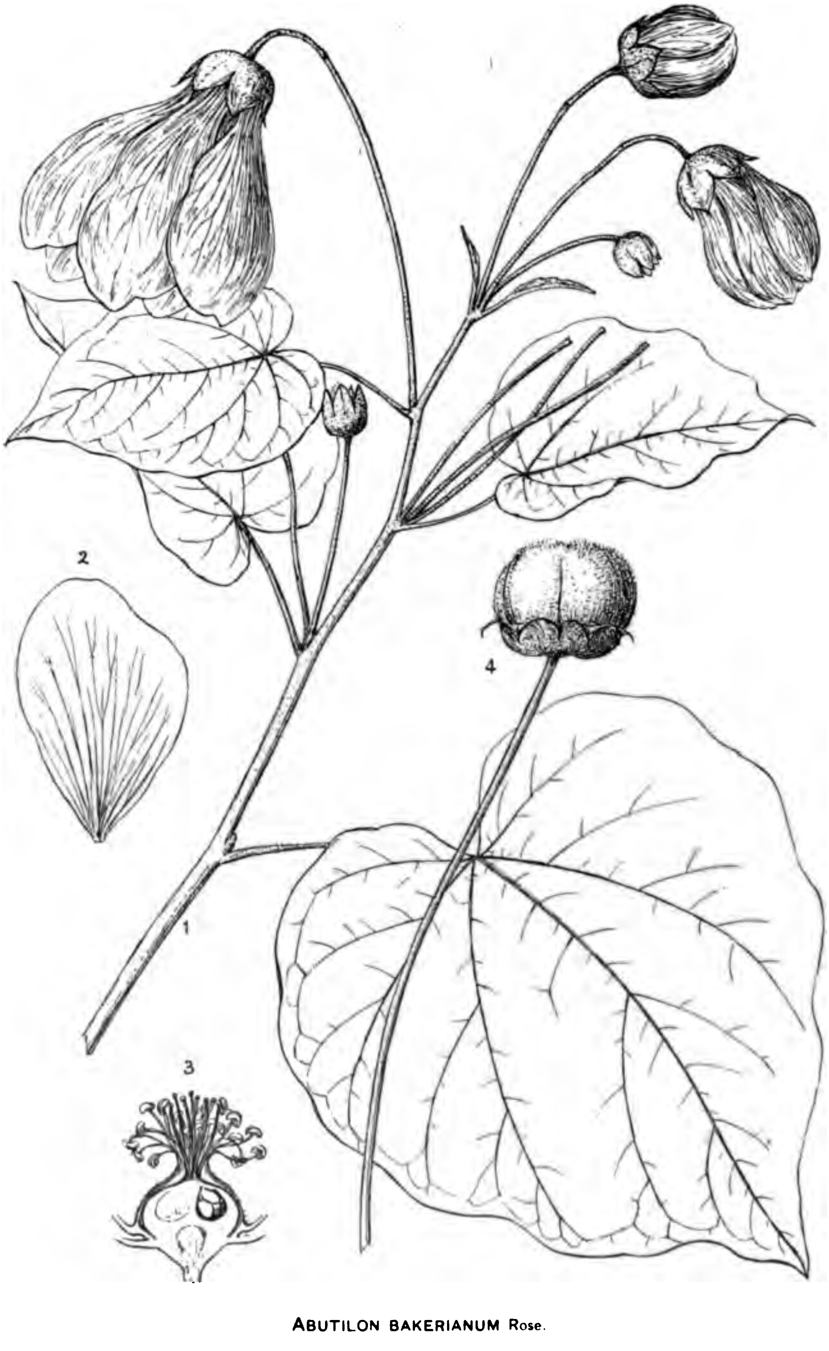
+ *Internodes much longer than the leaves; bracts often longer than the pedicels; sepals obtuse, clearly 3-nerved; petals shorter than the calyx; capsule as long as the calyx.*

Drymaria tenella Gray, Pl. Fendl. 12. 1849.

SPECIMENS EXAMINED.

Mexico:

State of Chihuahua, base of Sierra Madre, *C. G. Pringle* (No. 1194), September 21, 1887, and near Chihuahua (No. 581), October 2, 1885, and (No. 6480) 1897.



ABUTILON BAKERIANUM Rose.

New Mexico:

Pinos Altos Mountains, *E. L. Greene* (No. 332), September 8, 1880; *A. Fendler* (No. 56), 1847; also *C. Wright* (No. 868), 1851.

Colorado:

Dr. Hayden, 1869.

++ *Internodes slightly longer than the leaves; bracts always shorter than the pedicels; calyx always shorter than the pedicels; sepals rounded at apex, faintly 3-nerved; petals much longer than the calyx; capsule longer than the calyx.*

Drymaria confusa Rose, sp. nov.

Small glabrous annual, 5 to 7.5 cm. high, scarcely branching at base; radical leaves small, orbicular, 4 to 6 mm. long including the slender petiole; stem leaves linear, a little shorter than the internodes; pedicels sometimes 8 mm. long, nearly always twice longer than the calyx; sepals oblong, obtuse, scarious-margined; faintly 3-nerved, petals longer than the calyx, deeply 2-parted.

Collected by Dr. Edward Palmer in southwestern Chihuahua in 1885 (No. 59).

This species is near *D. tenella*, but of somewhat different habit, with longer pedicels, fainter nerves, somewhat differently shaped sepals, and longer petioles.

Distributed and listed[1] by Dr. Watson as *D. tenella*. 1886.

DESCRIPTIONS OF MISCELLANEOUS NEW SPECIES.

Abutilon bakerianum Rose, sp. nov. PLATE XI.

Small tree, 45 to 60 dm. high; branches, calyx, and young leaves with reddish stellate pubescence; leaves broadly ovate, cordate at base, acuminate, palmately 7 to 9-nerved, 10 to 12.5 cm. long, 8.7 to 12.5 cm. broad, green and somewhat stellate-pubescent above, paler, more reticulate and stellate beneath; margin slightly undulate; petioles 3.7 to 6.2 cm. long, peduncles 2 to 3 in the axils of the upper leaves, 3.7 to 10 cm. long, articulated about 12 mm. below the apex; calyx 8 mm. or less long, cleft to the middle; lobes 3 or 5, ovate, acute; corolla light yellow, 7.5 cm. in diameter; petals oblique, notched or sometimes cleft nearly to the base, nearly glabrous; staminal tube short; styles 12, as long as stamens, glabrous; fruit in our specimens immature, stellate-pubescent; carpels obtuse.

Collected by Mr. C. G. Pringle in the Tomellin canyon, State of Oaxaca, Mexico, altitude 3,500 feet, December 1, 1895 (No. 6278). This species must be near *A. macranthum* Peyr.[2] if not really that species. The name *A. macranthum* can not be used here, however, being preoccupied by a South American species; otherwise I should certainly have adopted it. Whether it shall prove to be Peyritsch's plant or an undescribed one, the above new name will hold. It is a pleasure to be able to dedicate such a handsome species to Mr. E. G. Baker, for without his careful monograph of this genus the determination of the species would have been almost a hopeless task.

Our plant comes near *A. discolor*[3] Baker fil. and *A. notolophium*[4] Gray (both founded upon Berlandier's 2163), but is apparently different. From the description, it differs especially in its much smaller calyx. I have not seen the type of either, but Mr. J. M. Greenman has kindly compared my specimens with the type specimens of the latter now in the Gray Herbarium. I quote the following from his letter of April 11, 1896:

> Having compared Pringle's No. 6278 Abutilon with the type sheets of *Abutilon notolophium* Gray, I would say that it differs from that species in the size of the calyx, in the lobing of the same, in the much shorter stamineal tube, in the correspondingly shorter styles, and finally in the more slender and somewhat more numerous pedicels. I do not believe it referable to *A. notolophium* Gray. In connection with

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[1] Proc. Am. Acad. 21: 417. 1886.

[2] Linnaea, 30: 59. 1859.

[3] Journ. Bot. 31: 73. 1893.

[4] Proc. Am. Acad. 5: 175. 1861.

Pringle's No. 6278, may I call your attention to Bourgeau's No. 2120 and also Ghiesbreght's No. 864. These are two unnamed species in the Gray Herbarium, and if not the same as Pringle's No. 6278, certainly stand very near.

EXPLANATION OF PLATE.—Fig. 1, flowering branch; fig. 2, petal; fig. 3, section of ovary, showing also styles and stamens; fig. 4, immature fruit; scale of all ⅓.

Abutilon nelsoni Rose, sp. nov. PLATE XII.

Shrub 6 to 18 feet high; young branches, petioles, young leaves, etc., densely covered with a coarse reddish scurfy stellate pubescence; leaves very large; stipules ovate, 10 to 12 mm. long, deciduous; petiole 2.5 to 10 cm. long, blade broadly ovate to orbicular, 25 cm. or less long, 22.5 cm. or less broad, deeply cordate at base, entire, acuminate, strongly veined beneath, finely and densely stellate-pubescent on both sides; flowers 1 or 2 in the axils of the upper leaves, very large, 10 to 12.5 dm. in diameter; peduncle 15 cm. or less long; calyx 37 mm. long, 5-lobed; sepals oblong, rounded and apiculate at apex, nearly one inch long, with short dense pubescence within, and with long, lanate stellate hairs without; petals a dark or orange yellow, 5 to 6.2 cm. broad, nearly orbicular, slightly oblique, becoming reflexed; stamen tube slender, conical; styles about 24, slightly longer than the stamens; carpels not seen. This species which is one of the largest, if not the largest, of the genus was collected by Mr. E. W. Nelson in Guatemala, December 18, 1895 (No. 3562). It belongs near *A. macranthum* St. Hil. (not Peyr.) possessing the same remarkable calyx, but with entire leaves, larger stipules, and differently colored petals, as well as other important differences.

Mr. Greenman of the Gray Herbarium writes me that they have nothing like it there.

EXPLANATION OF PLATE.—Flowering branch with leaves, scale ½.

Asimina foetida Rose, sp. nov.

A small shrub, 15 to 24 dm. high; young wood pubescent, old wood glabrate; leaves oblong, 10 to 20 cm. long, 3.7 to 7.5 cm. wide, obtuse or shortly acuminate, rounded at base, pubescent above or becoming glabrate in age, densely and softly pubescent beneath; petioles short, 2 to 6 mm. long, flowers solitary; peduncle about 18 mm. long, with an oblong, obtuse bract 6 to 14 mm. long; sepals 3, 12 mm. long, obtuse, densely pubescent; petals 6 to 9, very large 7.5 to 12.5 cm. long, oblong, obtuse, pubescent, brown in color; carpels (immature) 18 or more, stipitate, oblong, obtuse, 5 cm. long; seeds in two rows, flattened, 18 mm. long. The flowers have a very offensive odor, much resembling that of carrion.

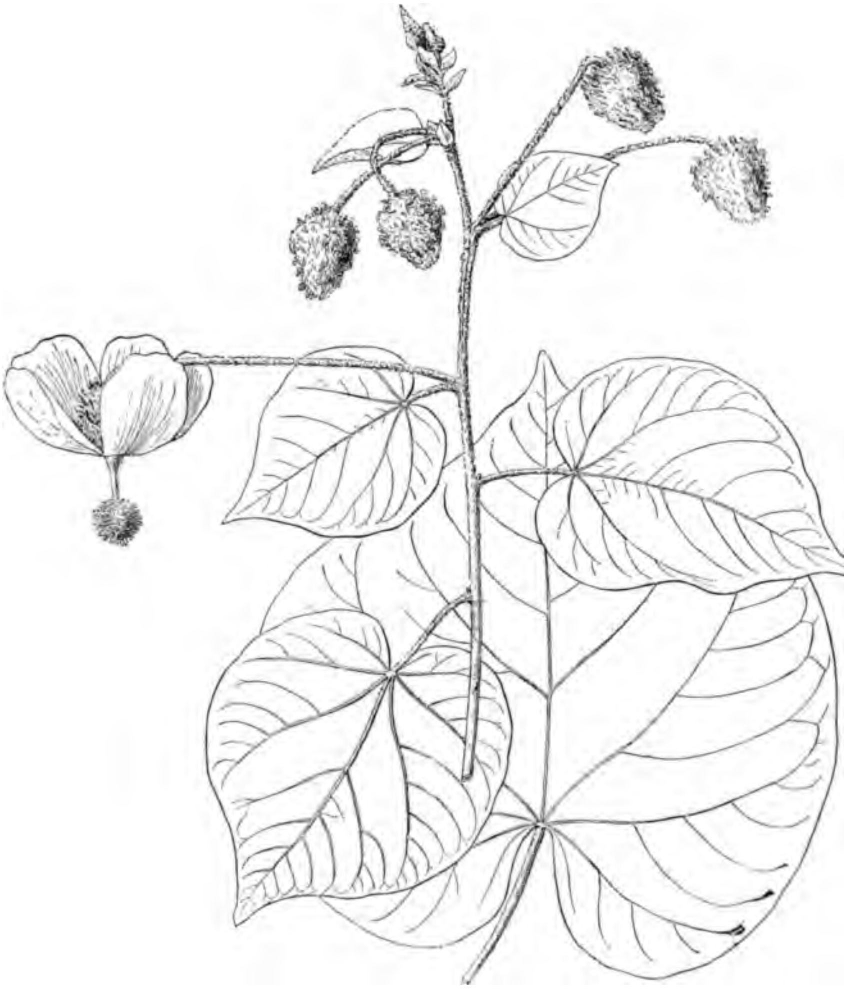
Collected by Dr. Edward Palmer near Acapulco, December, 1894 (No. 189), with fruit, and February, 1895 (No. 394), in flower. Here I am inclined to refer Marcus E. Jones's No. 2024 from near the city of Colima, collected July 2, 1892, although the flowers and bracts are larger and the leaves more pubescent.

This species is remarkable for its extremely large flowers, some of which measure 12.5 cm. in diameter.

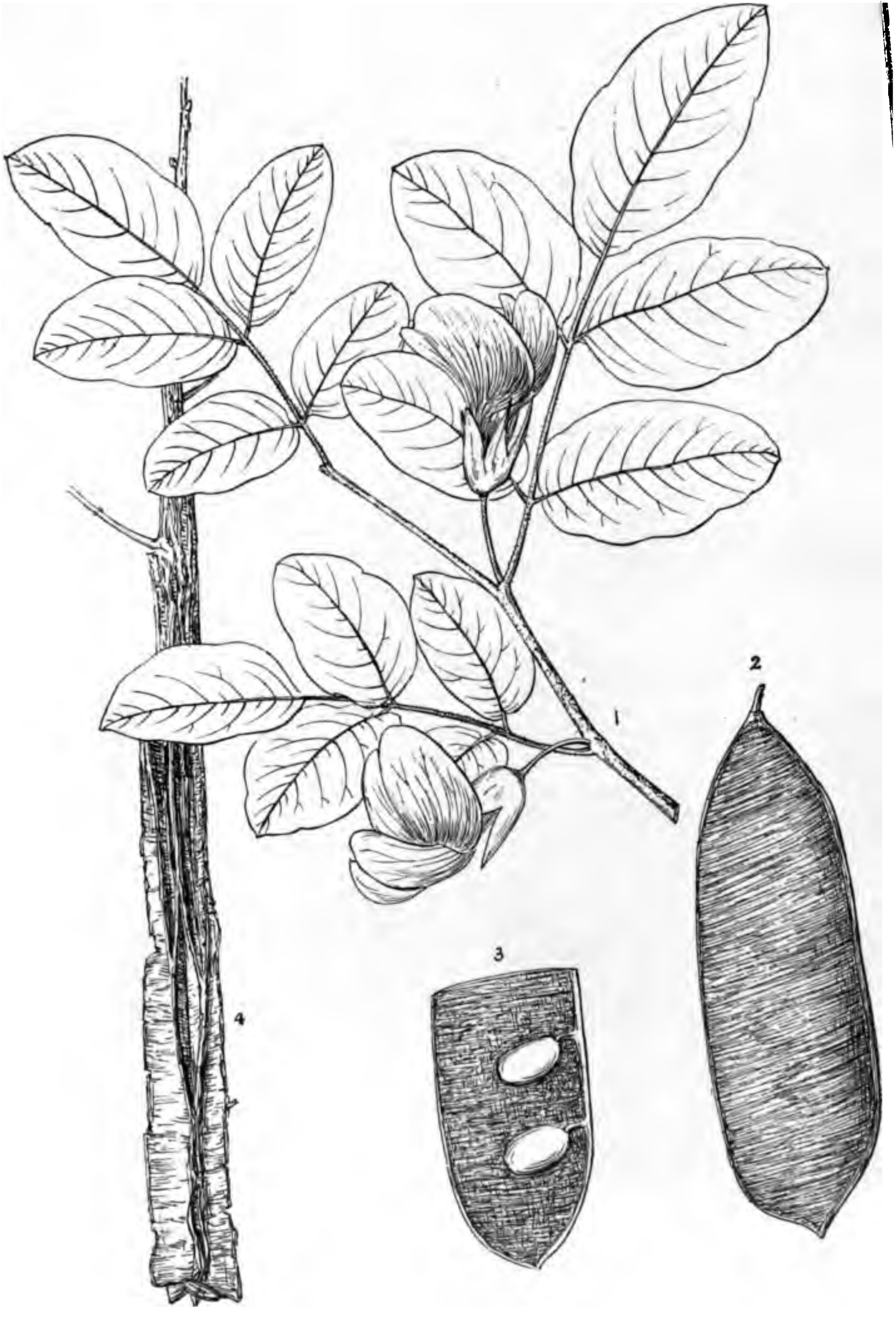
Brongniartia suberea Rose, sp. nov. PLATE XIII.

An upright shrub, 24 to 36 dm. high; the smaller branches often with 6 to 7 thin high ridges of cork; younger parts of stem, petiole, and peduncle pubescent; leaves alternate; stipules caducous, not seen but probably not large; leaflets 5, ovate to ovate-oblong, 2.5 to 5 cm. long, 12 to 30 mm. broad, rounded at base, rounded or acute at apex, apiculate, green and glabrous above, paler and somewhat pubescent beneath; flowers axillary, solitary and large; peduncle slender, 6 to 16 mm. long, pubescent; calyx nearly glabrous, somewhat 2-lipped; the lower lip deeply 3-cleft; the upper broader and simply notched or retuse; margins of sepals pubescent; corolla rather large, brownish or "cherry color with seal brown lines;" banner very large, broadly oblong, 14 mm. long, retuse; pods glabrous, oblong or somewhat broader above, tapering at base into a short stipe, obtuse or acutish, 37 mm. long, 16 to 18 mm. broad, 3 to 6-seeded; seeds oblong, 8 mm. long, light brown.

Collected near Acapulco, Mexico, by Dr. E. Palmer, December, 1894 (No. 178).



ABUTILON NELSONI Rose.



BRONGNIARTIA SUBEREA Rose.

This species is very distinct from any other of this genus with which I am familiar. The excessive development of cork on some of the younger branches is very peculiar. Dr. Palmer states that this cork soon disappears and is not found on the older wood.

EXPLANATION OF PLATE.—Fig. 1, flowering branchlet; fig. 2, pod; fig. 3, a part of pod showing seeds; fig. 4, a branch showing corky wings; scale of all ⅔.

Calliandra bijuga Rose, sp. nov.

A tree with wide-spreading top and trunk 20 to 22.5 cm. in diameter; branches with light gray bark, pubescent, soon becoming glabrate; stipules ovate, acute; petiole wanting or only 12 mm. long; rachis very short; pinnae 2 pairs; leaflets 9 to 12 pairs, oblong, 12 mm. long, acute, glabrous or nearly so, somewhat coriaceous, shining above, paler beneath; peduncles axillary, single or in twos, 2.5 cm. long; flowers capitate, sessile; calyx 2 mm. long, glabrous, hardly striate; carpels 6 mm. long; stamens 3.7 cm. long, bright crimson; pod 10 cm. long, 12 mm. wide, somewhat puberulent, acute, cuneate at base, with very thick margins.

In bottom lands at Acapulco; collected by Dr. Edward Palmer November, 1894 (No. 138).

A very handsome species, the crowded pinnae peculiar. This species belongs to the section Nitidae and the subsection Paucijugae.

Calliandra peninsularis Rose, sp. nov.

Pinnae always 6 pairs, leaflets about 20 pairs; the leaflets 4 to 6 mm. long, midvein eccentric, a little pubescent, acute; peduncle 3.7 to 5 cm. long, with numerous flowers; calyx less than 2 mm. long; petals 6 mm. long; pods 6.2 to 8.7 cm. long, considerably tapering at base, with thick margins and a little puberulent.

Only a single specimen collected, growing in a garden at La Paz. It is called "tabardillo," by which name yellow fever was known to the Indians. The root of this plant is now used by the people of this region as a remedy for fevers.

Collected by Dr. Edward Palmer, January 20 to February 5, 1890 (No. 22).

This is *Calliandra* sp. of the Contributions, Vol. I, p. 69. It belongs to Bentham's series Nitidae, near *C. Californica*.

Cassia nelsoni Rose, sp. nov. FIGURE 1.

Shrub 3 to 4.5 meters high, glabrous; young branches clothed with a reddish pubescence; leaflets 4 to 7 pairs, very unequal, obovate, the larger ones 2.5 to 5 cm. long, obtuse, pubescent beneath, glabrous and shining above; rachis pubescent, bearing usually a glabrous slender gland between the lower pair of leaflets, rarely also between the second pair; stipules setaceous, deciduous, 12 mm. long; flowers few in terminal clusters, very large, 6.2 cm. broad; pedicels and buds densely reddish-pubescent; sepals broad, somewhat unequal, 6 to 10 mm. long, nearly glabrate; petals oblong, 25 to 30 mm. long, very pubescent on the veins; fertile stamens

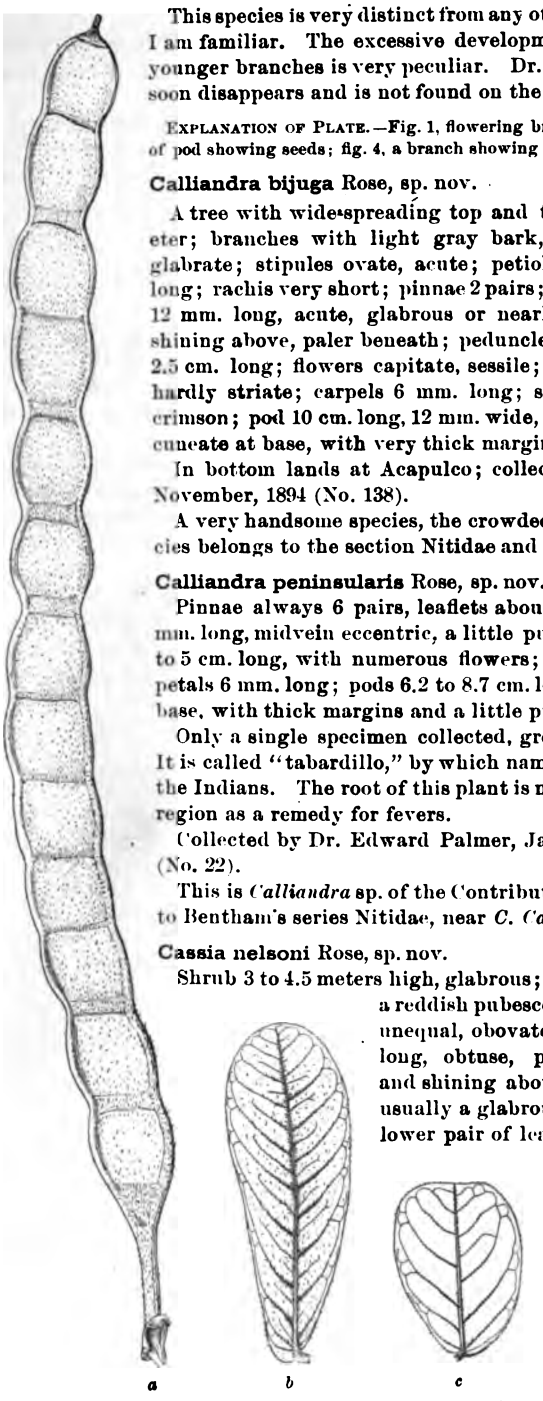


FIG. 1.—*a*, Legume of *Cassia nelsoni*, scale ⅔; *b*, *c*, forms of leaflets, natural size.

7, dehiscing by terminal pores, glabrous; ovary pubescent; legume (immature) becoming glabrate, 12.5 to 15 cm. long, 6 to 8 mm. wide, strongly flattened, articulated; stipe 10 mm. long.

Collected by E. W. Nelson between San Geronimo and La Venta, State of Oaxaca, July 13, 1895 (No. 2783), and also along road from Ocuilapa to Tuxtla, State of Chiapas, altitude 2,100 to 3,000 feet, August 29, 1895 (No. 3069); also by Mr. C. G. Pringle on lava beds near Cuernavaca, June 23, 1896 (No. 6340).

This species must be near the Brazilian *C. hypoleuca* Mart.

Cologania procumbens Kunth, Mimoses, 205, t. 57. 1819.

Collected by Mr. E. W. Nelson between Guichocovi and Lagunas, State of Oaxaca, altitude 187 to 289 meters, June 27, 1896 (No. 2750).

We have the following other specimens in the National Herbarium from Guatemala: Enrique Th. Heyde's Nos. 131 and 582, 1892; H. von Türckheim's No. 1419 (1888), from Santa Rosa, and W. C. Shannon's No. 4705 from Department of Guatemala, all in John Donnell Smith's distributions, in which the last two were sent out as *Galactia marginalis*, determ. Micheli.

Pringle's No. 4401 (1893) from Jalisco, also referred to the above, seems to belong to another species, differing from *C. procumbens* in that the pubescence of stem and petiole is erect instead of reflexed, the leaves much more elongated, and the flowers smaller. The species appears to be new and I would name and characterize it as below.

Cologania erecta Rose, sp. nov.

Stems from a woody base, erect, 7.5 to 15 cm. high, with rather close, erect pubescence; leaflets elongated, 10 to 15 cm. long, 4 to 8 mm. wide, rounded at base, somewhat tapering toward apex, but with obtuse apiculate tip; calyx 4 mm. long; pod 2.5 to 3.7 cm. long, 3 mm. wide, pubescent.

Collected by Mr. C. G. Pringle on rocky hills near Guadalajara, June 21, 1893 (No. 4401).

Combretum palmeri Rose, sp. nov.

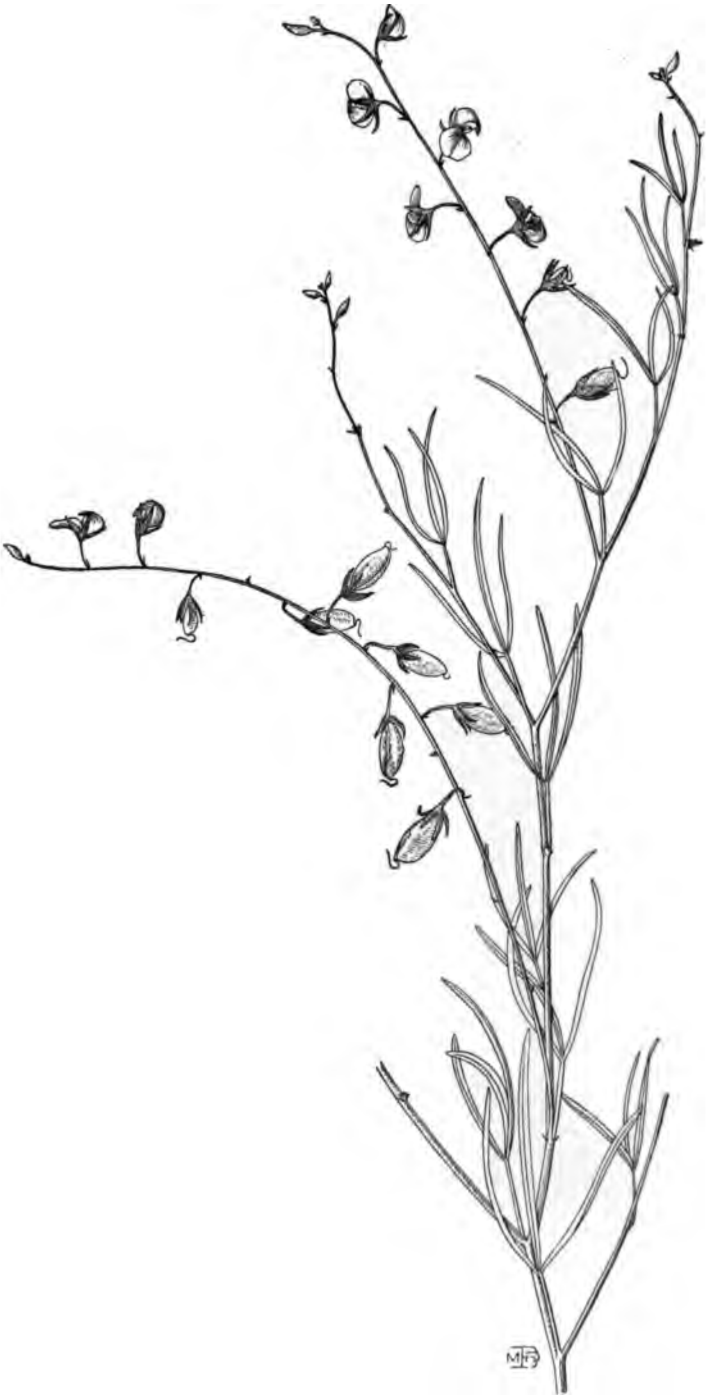
A high-climbing woody vine; branchlets opposite or alternate, clothed with a short velvety pubescence, subtended by short straight spines; leaves opposite, oblong, obtuse, truncate or rounded at base, 5 to 6.2 cm. long, glabrous above, paler and pubescent beneath, especially along the veins, becoming glabrate; petioles short but distinct; inflorescence paniculate, more or less pubescent; spikes slender, loosely flowered; bracts setaceous shorter than the glabrous ovary; calyx turbinate, glabrous without, 5-toothed, thin; teeth shorter than the tube; petals "white" or yellow, short, oblong, 2 mm. long, obtuse, inserted at the top of calyx tube, alternate with the lobes; stamens 10, long-exserted, glabrous; 5 inserted with the petals, 5 near the middle of the calyx tube; ovary 1-celled, 5 to 8-ovuled; fruit 1-seeded, 12 mm. long, with 5 thin equal wings.

Very common in bottom lands; collected by Dr. Edward Palmer near Acapulco, February, 1895 (No. 396).

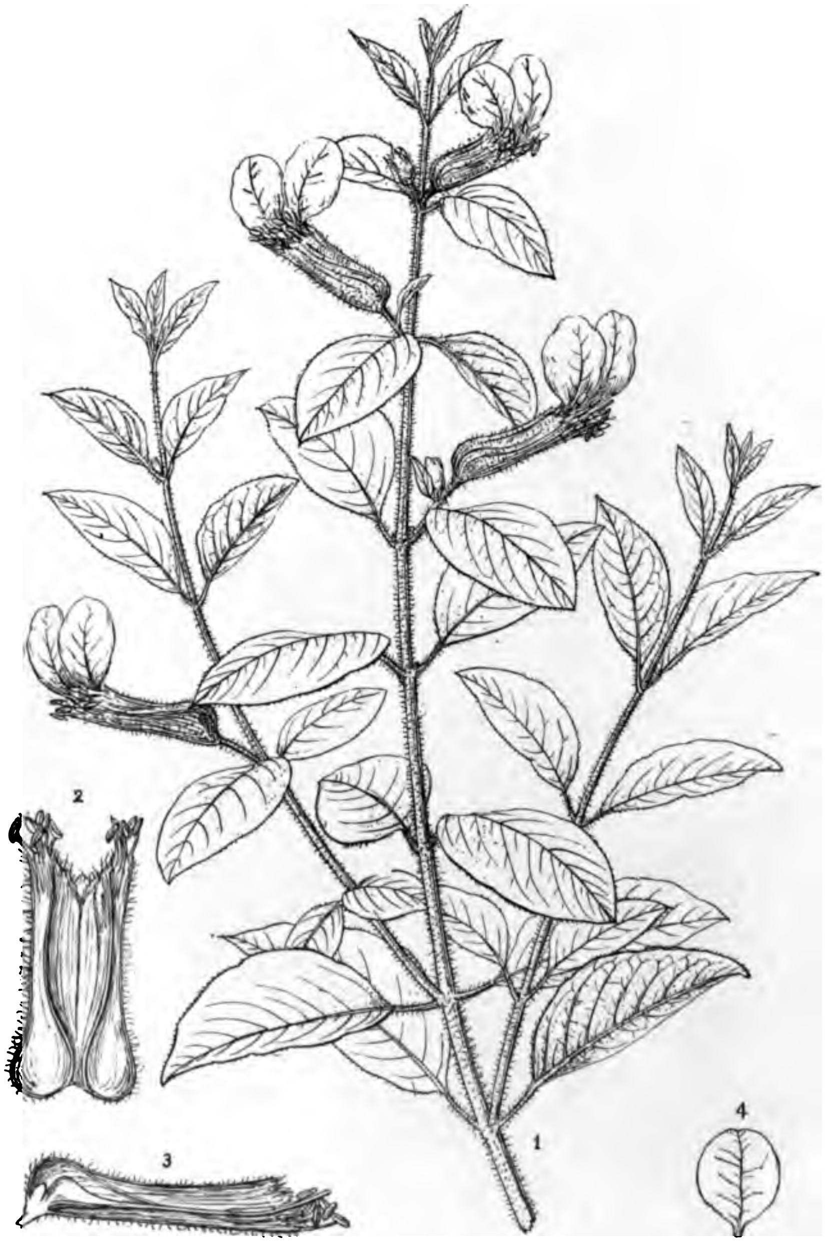
This species differs from all our American species in being thorny. Dr. Palmer states that it grows over the tallest trees about Acapulco, and that the flowers are white and as sweet-scented as apple blossoms.

Crotalaria filifolia Rose, sp. nov. PLATE XIV.

Perhaps annual, 6 to 12 dm. high, usually several stems in a clump, somewhat branching above, green and nearly glabrous; leaves on petioles 12 to 18 mm. long; stipules small; leaflets 3, linear, elongated, 2.5 to 5 cm. long, acute, slightly pubescent; racemes slender, few-flowered (6 to 15), opposite the leaves and much longer (10 to 20 cm. long); bracts small, linear; pedicels slender, 6 to 8 mm. long, at first erect, but reflexed in fruit; sepals narrow, acute, 4 mm. long; corolla small, yellow often tinged with purple; banner orbicular; keel strongly curved, acuminate, margins slightly ciliate; wings much shorter than the keel, obtuse, ciliate on margins; imma-



CROTALARIA FILIFOLIA Rose.



CUPHEA NELSONI Rose.

ture pod with dense grayish pubescence, more or less purplish like the calyx, pedicels, and bracts.

Collected by Mr. C. G. Pringle on lava beds near Cuernavaca, September 15, 1896 (No. 6553).

Explanation of Plate.—A branch showing leaves, pods, and flowers; scale ⅓.

Cuphea (Diploptychia) empetrifolia Rose, sp. nov.

Stems woody; branches somewhat pubescent; leaves small, 10 to 12 mm. long, linear and narrowly oblong, glabrous and shining above; calyx purplish, 16 mm. long, strongly gibbous at base, slightly enlarged upwards, hispid without, a large yellow gland (?) near the insertion of each dorsal petal and prominent ridges within, almost surrounding the ovary and style; ridges glabrous; dorsal petals 2, purple, oblong, 8 mm. long, rounded at apex, slightly stalked; ventral petals 4, minute, 2 mm. long, oblong; stamens 11, exserted, glabrous throughout; ovary glabrous, about 20-ovuled; gland dorsal, channeled on the back, reflexed.

Collected by Mr. E. W. Nelson on the top of the Sierra Madre near Chilpancingo, altitude 2,650 to 3,000 meters, December 24, 1894 (No. 2199).

This species is near *C. hookeriana*, but has very different foliage, flowers, etc.

Cuphea (Diploptychia) nelsoni Rose, sp. nov. Plate XV.

A shrub 9 to 15 dm. high with many long, slender, purplish branches, strongly hirsute; leaves opposite, lanceolate to broadly ovate, slightly tapering at base, acute or shortly acuminate, scabrous above, hispid on both edges, paler and strongly veined beneath, 2.5 to 5 cm. long including the slender petiole (4 to 10 mm. long), 12 to 28 mm. wide; flowers solitary; calyx 20 to 28 mm. long, slightly gibbous at base, thickly covered with stiff purplish hairs, glabrous within, and with two narrow ridges extending to the base; petals 2, dorsal, large, 8 to 10 mm. long, deep scarlet; stamens 11, exserted, glabrous; gland dorsal, horizontal; ovules 10.

Collected by Mr. E. W. Nelson between Jacallenango and San Martin, altitude 1,705 to 2,303 meters, December 24, 1895 (No. 3600).

This species has very handsome flowers, its petals being among the largest of the genus.

Explanation of Plate.—Fig. 1, a flowering branch; fig. 2, calyx cut open showing the two internal ridges; fig. 3, a different view of the calyx showing dorsal gland, etc.; fig. 4, petal; fig. 1, scale ⅔; figs. 2, 3, and 4 somewhat larger.

Galactia acapulcensis Rose, sp. nov.

Climbing over small shrubs, somewhat pubescent; leaflets 3, oblong, 3.7 to 5 cm. long, 18 to 30 mm. wide, obtuse, apiculate, rounded at base, thinnish, glabrous and shining above, with short and appressed pubescence beneath; inflorescence an interrupted slender raceme, 8 to 10 cm. long, clothed with a whitish pubescence; flowers in clusters of 3 or 4; pedicels 2 mm. long, bracts 2, ovate, small; calyx 4-lobed; sepals oblong; petals normal, "rose-colored;" legume oblong, rounded or somewhat cuneate at base, 3.7 to 5 cm. long, 6 mm. broad, clothed with stiff scattering hairs.

Collected by Dr. Edward Palmer near Acapulco, Mexico, November, 1894 (No. 135).

Near *G. glabella*, but with thinner leaves, somewhat different pods, etc.

Galphimia glandulosa Rose, sp. nov.

Shrub; leaves opposite, lanceolate, acute or obtuse, apiculate, cuneate at base, 3.7 to 6.2 cm. long, including the slender biglandular petiole, with entire somewhat revolute margins; racemes terminal, slender, 10 to 14 cm. long; calyx 3-glandular; sepals oblong, obtuse; petals yellow; anthers yellow, oblong, longer than the filaments; ovary pubescent; styles 3, filiform; fruit puberulent.

Collected by Dr. Edward Palmer in river bottoms near Acapulco, February, 1895 (No. 474).

This species differs from all the others of the genus in having a glandular calyx. These glands alternate with the sepals.

Gouania pallida Rose, sp. nov. FIGURES 2, 3.

High climber; branches glabrous and glaucous; leaves oblong, obtuse, slightly cordate, glabrous, paler beneath, margins with remote teeth, slender-petioled; stipules very large, reniform, obtuse; racemes 2.25 to 2.50 dm. long; flowers white, sweet-scented.

In river bottoms climbing over large bushes; collected by Dr. Edward Palmer, Acapulco, December, 1895 (No. 228).

This plant differs from *G. stipularis*, the only other species possessing large stipules, in the shape of the leaves, which are less heart-shaped at base and have the margin more toothed, and in its much longer racemes, as well as in the stipules themselves.

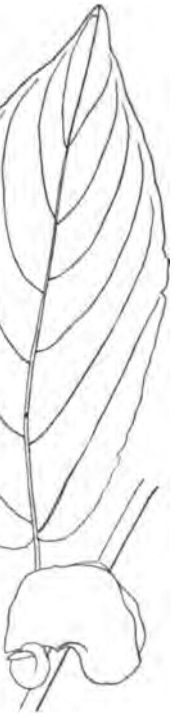


FIG. 2.—Leaf and stipules of *Gouania pallida*, scale $\frac{2}{3}$. (From a specimen in U. S. National Herbarium.)

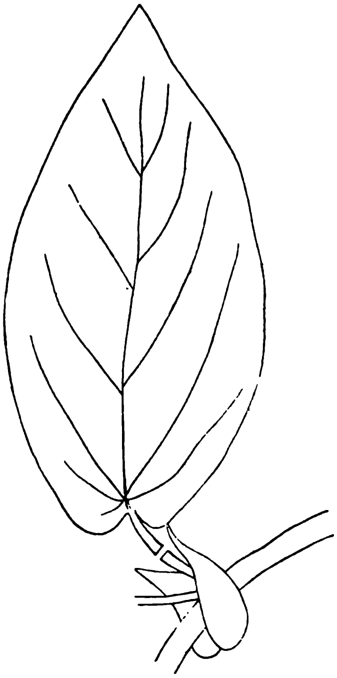
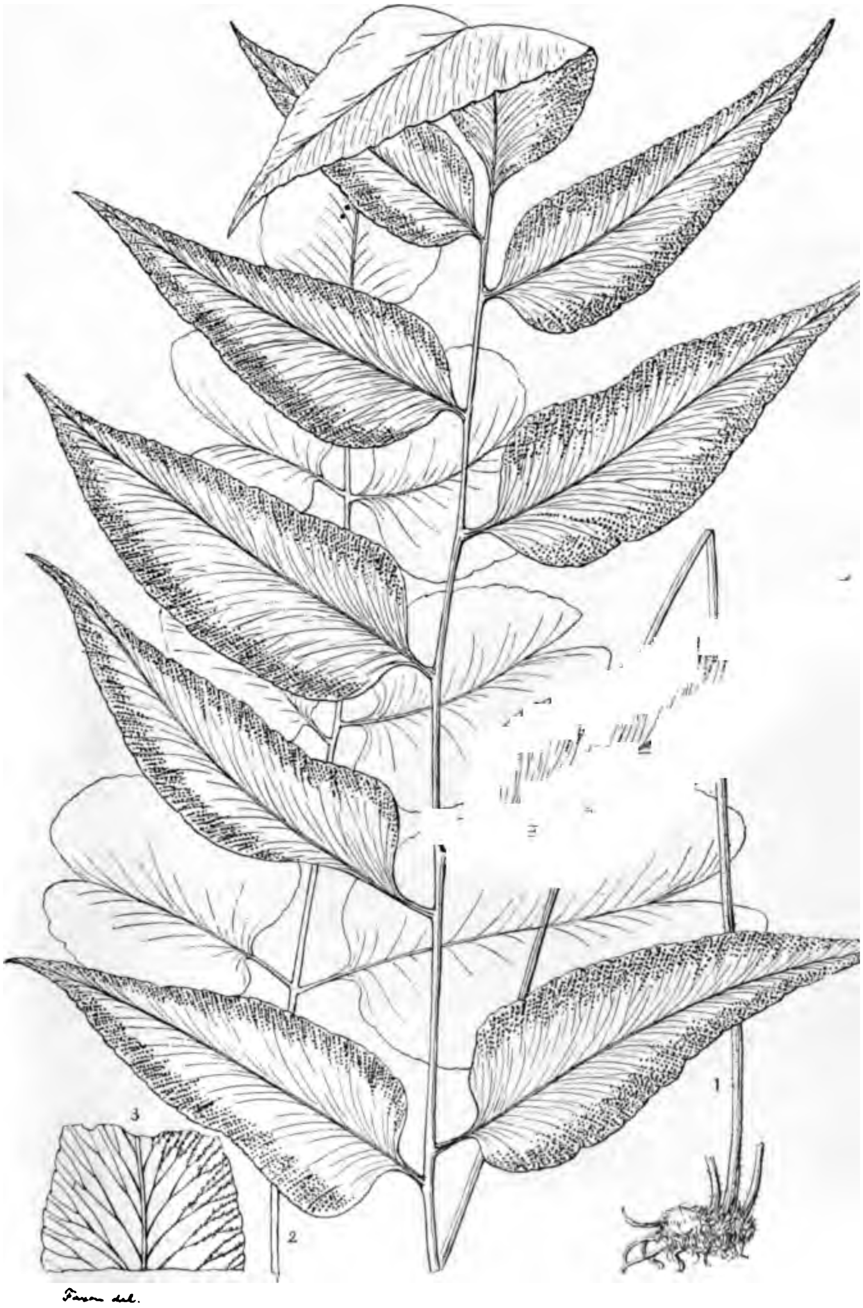


FIG. 3.—Leaf and stipules of *Gouania stipularis*, scale $\frac{2}{3}$. (From a tracing, somewhat modified, of the original specimen.)

Gymnogramme subcordata Eaton & Davenport, sp. nov. PLATE XVI.

Fronds clustered on a short stout rhizoma, the latter clothed with dark brown slightly fibrillose scales, the stipes and rachises chaffy with more or less deciduous pubescence, surfaces naked, or minutely villous; stipes 15 to 22 cm. long, and, as well as the rachises, straw-colored (in young plants dark); laminae 10 to 22 cm. long, 7.5 to 17.5 cm. broad, pinnately divided into from 3 to 6 pairs of lanceolate, acuminate, subcordate stalked pinnae 5 to 8.7 cm. long, and a terminal pinna with an unequally one-sided or subcordate base; pinnae entire, or in the largest forms, deeply lobed with unequally rounded lobes, some of the basal lobes distinct, and, especially in the lowest pinnae, lance-ovate, acuminate, the lowermost 3.7 to 5 cm. long; or sometimes the pinnae imperfectly developed, then nearly reniform with the apex cleft



GYMNOGRAMME SUBCORDATA Eaton & Davenport.

into two lobes; margins entire or slightly crenately cut and toothed; texture thinly herbaceous; veins uniting below into two series of long irregular areolae, the lower series parallel with the costa, the secondary series obliquely ascending, forked once or twice above and free to the edge; sori confined to the free veinlets.

Habitat, Ymala, and Lodiego; collected by Dr. Edward Palmer (Nos. 1416 and 1572), August and October, 1891.

[Type specimen in U. S. National Herbarium.]

I regard the privilege of describing this unpublished species of Prof. Daniel Cady Eaton, to whom I have been indebted for so many and great courtesies, as a very great honor, and I trust that I have exercised due care in discharging the pleasant duty assigned to me by Dr. Rose. I have given to the specimens a very careful examination, although my confidence in Professor Eaton's judgment would have led me to accept of his determination without doing so.

In the brief note accompanying the naming of this fern Professor Eaton expressed the opinion that it was "near to *G. japonica* in venation, but more tender, and with pinnae of different shape," but it seems to me to differ from that species quite as much by its venation as by any of its other characters, and I believe that it will stand as a good species.

GEORGE E. DAVENPORT.

MEDFORD, MASS., *January 20, 1896.*

EXPLANATION OF PLATE.—Fig. 1, fertile frond; fig. 2, sterile frond; figs. 1 and 2, natural size; fig. 3, fragment of a pinna showing fruit dots, somewhat enlarged.

Heteropterys acapulcensis Rose, sp. nov.

A large climbing shrub; bark of reddish-brown color, densely spotted with small lenticels; leaves lanceolate, 7.5 to 15 cm. long, 2.5 to 5 cm. wide, acuminate, rounded at base, glabrous, dark green with reddish veins above, yellowish green beneath with more prominent veins, not glandular at base; flowers in short axillary panicles; calyx 10-glandular; petals yellow; stamens 10, all antheriferous; styles 3; samarae single, oblong, obtuse, with grayish pubescence, without lateral crests, the wing bearing a single tooth on the back. Collected by Dr. Edward Palmer near Acapulco, December, 1894 (No. 219).

This species is very different from the other Mexican species.

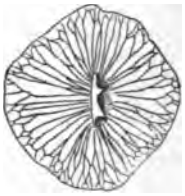


FIG. 4.—Samara of *Hiraea polybotrya*, scale ½.

Hiraea parviflora Rose, sp. nov. FIGURE 4.

Shrub, 15 to 24 dm. high; older branches brownish, becoming glabrate; leaves small, less than 2.5 cm. long, oblong, acute, rounded at base, densely tomentose on both sides (as also the young branches), shortly petiolate; umbels 2-flowered, short-peduncled; pedicels slender, 12 mm. long, bibracteate, some distance below the middle; calyx villose, 8-glandular; petals glabrous, orbicular, small, 4 mm. long, tapering at base into a slender claw, violet; stamens 10, glabrous, free nearly to the base; samarae 3, villose, 14 mm. in diameter, the lateral wing giving a circular outline; dorsal wing very small.

Collected by Mr. C. G. Pringle on dry hills near Tehuacan, altitude 5,500 feet, November 27, 1895 (No. 6274).

This species was distributed by Mr. Pringle in 1896 as *H. polybotrya*, which, however, is a very different plant. In this connection I might state that this latter species has been collected by Mr. Pringle the past season (1896) and distributed as No. 6500. It may be briefly described as follows:

Leaves large, sometimes 3 inches long, scantily pubescent on the lower surface, above nearly glabrous; petals denticulate, tapering at base into a slender claw, 3 lines long, violet color; samarae 3, 20 to 25 mm. in diameter, becoming nearly glabrate, the lateral wings united giving a circular outline, dorsal wing minute.

I am indebted to Mr. W. Botting Hemsley for comparing my plant with the specimens at Kew.

Indigofera cuernavacana Rose, sp.nov.

Branches herbaceous, somewhat pubescent, perhaps becoming glabrate, younger parts reddish-pubescent; leaves rather large, 10 to 12.5 cm. long including the petiole (less than 2.5 cm. long); stipules minute; leaflets oblong, 20 to 30 mm. long, obtuse and apiculate, rounded or slightly narrowed at base, petiolulate, strigose-pubescent on both sides, reddish on the young leaves; stipels like but smaller than the stipules; racemes slender, many-flowered, shorter than the leaves, on very short peduncles; calyx, corolla, and ovary reddish-pubescent; calyx spreading, cleft to the middle; legumes numerous, reflexed, nearly straight, terete, 2.5 cm. long, acute, slightly pubescent.

Collected by Mr. C. G. Pringle in a barranca near Cuernavaca, Morelos, 1896 (No. 6323).

Here perhaps belongs Bourgeau's No. 1192, from the same locality, reported in the Biologia Centrali-Americana by Mr. Hemsley without specific name.

Indigofera fruticosa Rose, sp. nov.

A shrub 9 to 15 dm. high; young branches clothed with a rather rough pubescence, either whitish or reddish, interspersed with brownish glands; leaves oddly pinnate; leaflets 3 to 5 pairs, opposite, very variable, mostly oblong, obtuse, strongly apiculate, slightly narrowed at base, petiolulate, sometimes obovate and retuse, 8 to 14 mm. long, whitish with dense appressed pubescence on both sides; stipules linear, somewhat pubescent; rachis with a ring of glands at the base of each pair of leaflets; stipels conspicuous; racemes 10 to 12.5 cm. long, much longer than the leaves, many-flowered; calyx reddish-pubescent, deeply cleft into linear sepals; outer lobes of corolla pubescent; ovary densely pubescent, tipped with a thick glabrous style; legumes at first reflexed but somewhat spreading when mature, 3.7 cm. long, strongly flattened, 4 mm. wide, somewhat curved, the pubescence reddish and somewhat spreading.

Collected by T. S. Brandegee in Lower California, at San Jose del Cabo, September 2, 1890 (No. 130); also at El Taste, September 12, 1893.

This is recorded as *Indigofera* sp. by Brandegee.[1] It is nearest *I. palmeri* Wats., being of similar habit and foliage but with longer racemes, sepals longer than calyx tubes, legumes longer, broader, and flatter, etc.

Indigofera salmoniflora Rose, sp. nov.

About three feet high, appressed-pubescent; buds, young leaves, calyx, and petals rusty-pubescent; leaves pinnate; leaflets 7 to 9, oblong, 20 to 36 mm. long, rounded or broadly cuneate at base, obtuse, appendiculate, glabrous above, silvery and appressed-pubescent beneath; racemes about the length of the leaves; flowers salmon or pink; banner orbicular, obtuse, sessile, 4 mm. long; anthers with purple connective, appendiculate; legume reflexed, about 2.5 cm. long.

Collected by Dr. Edward Palmer at Ymala, September 25 to October 8, 1891 (No. 1695); also a specimen (letter I) without number and locality, but probably from near the same station.

Leucaena glabrata Rose, sp. nov.

A tree 9 meters high, with large top and a trunk 3 dm. in diameter, glabrous throughout; leaves bipinnate (as in the genus), rather large; pinnae 4 to 7 pairs; rachis bearing a large cup-shaped gland between the pinnae of the uppermost (rarely the uppermost two) and of the lowermost pairs; leaflets 12 to 16 pairs, linear, 10 to 16 mm. long, oblique and broadly cuneate at base, acute, midrib eccentric, placed above the middle; heads axillary; peduncles 12 to 36 mm. long; calyx 2 mm. long, truncate or with small slightly ciliate teeth; petals 4 mm. long, linear; stamens 10; ovary glabrous; legume 15 to 20 cm. long, 18 mm. broad, glabrous and shining, tapering at base into the short stipe (12 mm. long), rounded and with a short straight apiculation.

Collected by Dr. Edward Palmer near Acapulco, Mexico, February, 1895 (No. 368).

This species is nearest *L. glauca*, but differs from it in having smaller pubescent flowers and ovaries, as well as smaller, narrower pods with a sharper curved beak. The green pods of this species are often used as food, and are found for sale in the markets of Acapulco. The tree is sometimes cultivated, and like some of the other species of the genus is called "guage."

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[1] Proc. Cal. Acad. ser. 2, 3: 126.

Leucaena microcarpa Rose, sp. nov.

A small tree 6 meters high; branches glabrous; pinnae 2 or 3 pairs; leaflets 3 to 5 pairs, large, elliptical to obovate, somewhat oblique, 2 to 4 cm. long, acute, rounded at base, nearly glabrous; rachis bearing a gland at the insertion of the uppermost and lowermost pairs of pinnae; legumes small, 7.5 to 12.5 cm. long including the slender stipe (12 to 18 mm. long), 10 to 14 mm. broad, glabrous.

Collected by Mr. T. S. Brandegee at Miraflores, Lower California, October 13, 1890 (No. 186).

Mr. Brandegee says it is found among bushes between the mountains and the sea.

Lychnis mexicana Rose, sp. nov.

Stems slender, 3 to 6 dm. high, erect, more or less lanate, especially above, not glandular; leaves linear, elongated; flowers upon elongated peduncles, somewhat nodding; calyx ovoid, 5-toothed, 8 mm. long; sepals densely lanate on the margins; petals 5, 8 mm. long, including the long narrow claw, oblong, not bifid, sometimes with lateral teeth and then appearing somewhat 3-lobed, without crest, purplish; stamens 10; styles 5; capsule longer than the calyx, splitting into 5 valves.

Collected by Mr. C. G. Pringle in the Sierra de Ajusco, altitude 3,215 meters, 1896 (No. 6456).

This species much resembles *L. drummondii* in habit but has different calyx, pubescence, and petals and narrower leaves.

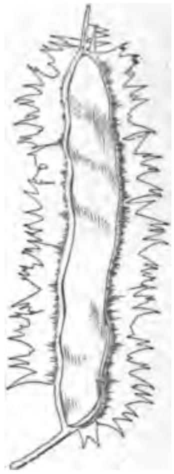


FIG. 5.—Legume of *Mimosa lacerata*, showing broad lacerate replum; scale ½.

Mimosa cærulea Rose, sp. nov.

Stems erect, 6 to 9 dm. high, without prickles and nearly glabrous; leaves small; stipules linear, small; petioles 18 to 30 mm. long; pinnae 1 pair; leaflets 8 to 12 pairs, 10 to 16 cm. long, oblong, acute, glabrous on both sides and somewhat glaucous above, the margin with appressed hairs; flowers in small heads, bluish; peduncles 2.5 cm. or less long, 3 to 4 in the axils of the leaves; corolla 4-toothed; stamens 4, with rather broad and flattened filaments; legume linear, 3.7 cm. long, constricted between the seeds, long-stipitate, acuminate, glabrous except a few prickles along the margins, 3 or 4-seeded.

Collected by Mr. C. G. Pringle on foot hills above Cuernavaca, Morelos, altitude 1,968 meters, November 18, 1895 (No. 6200), and 1896 (No. 6385).

This species most resembles *M. xanti* Gray, but has glabrous legumes, etc.

Mimosa lacerata Rose, sp. nov. FIGURE 5.

A shrub 15 to 24 dm. high, much branched; younger branches somewhat puberulent; prickles infrastipular, twinned, straight and stout; stipules linear, small; leaves pubescent; pinnae 8 to 12, 12 to 24 mm. long; leaflets 15 to 20, minute, linear, 2 mm. long; petiolule bearing 2 small glands; peduncles axillary, 2.5 cm. or less long; flowers capitate; stamens 10 (?); legume glabrous, flattened, stipitate, 3.7 to 8.7 cm. long; valves 6 mm. broad, not articulated; margin of legume nearly as broad as valves, thin and unequally cleft (often to the middle) into sharp spiny teeth.

Collected by Mr. E. W. Nelson from the vicinity of Piaxtla, Puebla, altitude 1,279 meters, November 24, 1894 (No. 2008); also by Mr. Pringle on limestone hills near Tehuacan and Esperanza, altitude 1,968 meters, December 23, 1895 (No. 6247); fruit also sent from Cuernavaca, 1896 (with No. 6384).

This species is very remarkable on account of the peculiar broad lacerate margin of the legume. The habit of the plant is much like that of *M. acanthocarpa* Benth. It should doubtless be referred to the section Acanthocarpae.

Minkelersia pauciflora Rose, sp. nov.

A vine 12 to 24 dm. high, pubescent; leaflets 3, ovate, obtuse, apiculate, 25 to 30 mm. long, 16 to 20 mm. broad; lateral leaflets more or less oblique, truncate at base, dark green above, nearly glabrate; stipules broadly ovate, membranaceous; racemes long-peduncled, 7.5 to 15 cm. long, few (4 to 6?)-flowered; bracts large, resembling the stipules, each subtending two flowers; bractlets 2, linear; calyx tube a little over a line high; sepals oblong, obtuse, 4 mm. long; corolla 12 mm. long; ovary straight, linear, densely hairy.

Collected by Mr. E. W. Nelson 18 miles southwest of the city of Oaxaca, altitude 2,146 to 2,952 meters, September 10 to 20, 1894 (No. 1362).

Minkelersia multiflora Rose, sp. nov.

Vine, a little pubescent and slightly scabrous; leaflets 3, ovate, acute, slightly pubescent, rather strongly veined, about 5 cm. long; the lateral with mid-vein strongly eccentric and broad nearly truncate base; terminal one nearly regular with broad cuneate base; petioles 3.7 to 5 cm. long; stipules membranaceous, broadly ovate, acute, 10 mm. long; stipels small; racemes axillary, many flowered (15 or more), often 20 to 25 cm. long when mature including the slender peduncle (7.5 to 10 cm.); bracts conspicuous, of the size and shape of the stipules, each subtending 2 flowers; buds erect, flowers spreading, after anthesis reflexed; calyx tube almost 4 mm. long, much shorter than the lobes; 4 lower sepals lanceolate, acute, 6 mm. long; upper sepal broader and 8 mm. long; style hairy below the stigma; ovary linear, straight, hairy.

Collected by Mr. C. G. Pringle, in Valley of Mexico, 1896 (No. 6471); also by Bourgeau at Pedregal, Valley of Mexico, 1865–1866 (No. 576), and referred by Mr. Hemsley in the Biologia (Vol. I. p. 307) to "*Phaseolus* sp."

This species differs from typical Minkelersia only in its numerous flowers and perhaps shorter calyx. It differs from all species of Phaseolus in its calyx, but in foliage more resembles that genus than do the other species of Minkelersia.

Two other species of Minkelersia have been described, both of which are rare in herbaria. *M. galactioides* is only known from the type collection of Galeotti, whose specimens came from Oaxaca. Unfortunately neither Pringle or Nelson came across the plant in their extensive collecting in that State. We have a single specimen of *M. biflora* obtained by Mr. Pringle in Chihuahua in 1887 (No. 1232). The only other collection of this species is the type (Schaffner's) from the Valley of Mexico.

Passiflora nelsoni Master & Rose, sp. nov. PLATE XVII.

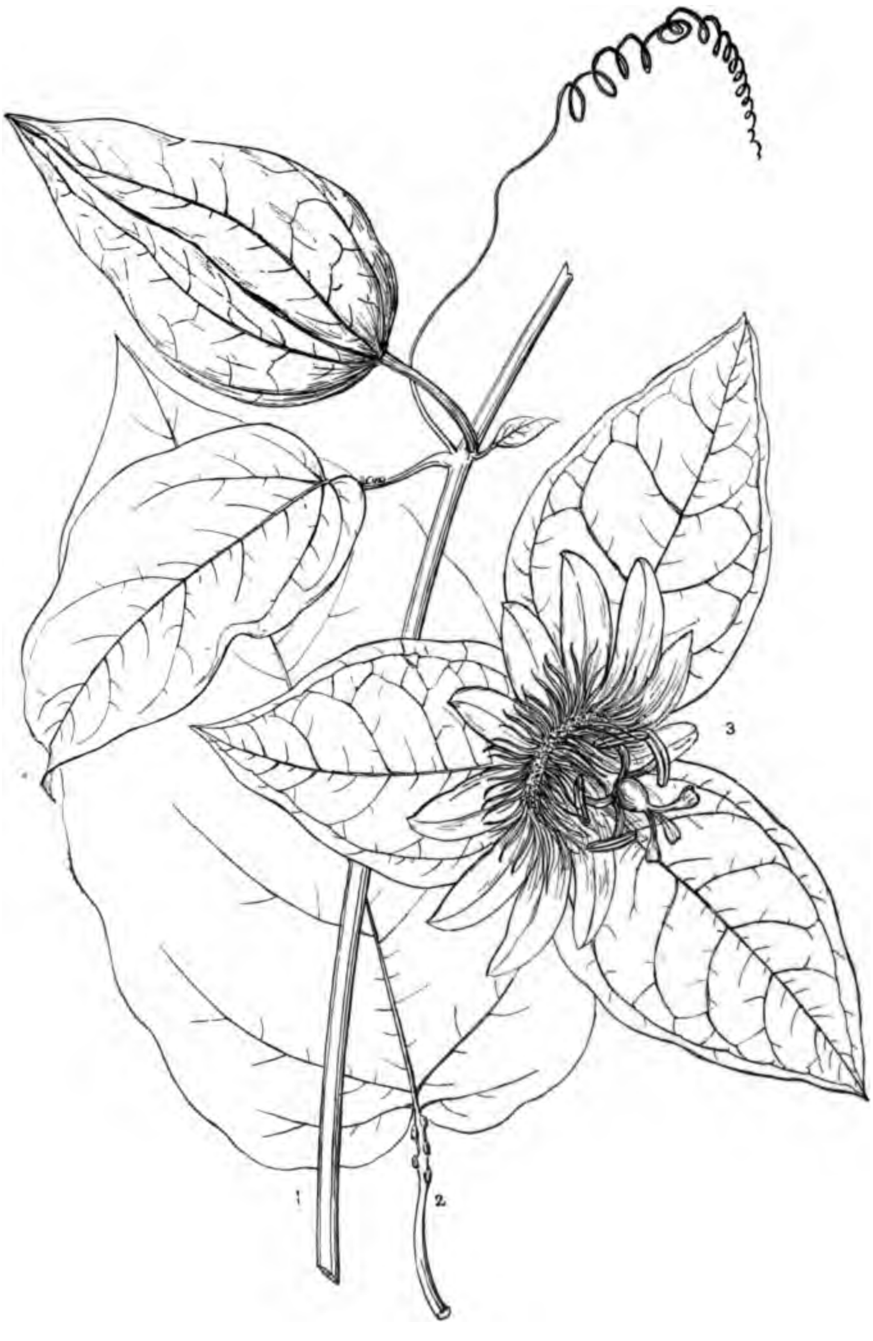
Usually an erect herb, 6 to 15 dm. high, glabrous; tendrils none or sometimes present; leaves simple, large, one-nerved, glabrous; blade ovate, 10 to 12 cm. long 7.5 to 10 cm. wide, acuminate, rounded or slightly cordate at base, entire, smooth; petiole 25 to 37 mm. long, glabrous with 4 sessile obtuse glands near the top; stipules linear, acute, entire, 12 mm. long; peduncle as long as petiole, solitary and axillary; bracts distinct, very large, broadly ovate, 7.5 cm. long, 5 cm. broad, shortly acuminate, 3-nerved, entire; sepals 30 mm. long, narrowly oblong, obtuse, apiculate; petals 5, about the length and shape of petals; crown fimbriate, about two-thirds the length of petals.

Collected by Mr. E. W. Nelson near Tumbala, State of Chiapas, altitude 1,312 to 1,609 meters, October 20, 1895 (No. 3325), and in Guatemala by Capt. John Donnell Smith.

This species belongs in section Granadilla and is perhaps nearest the species *guazumifolia*.

A very remarkable species on account of the enormously large bracts. Much resembling *P. laurifolia* but with larger leaves, more glands on the petiole, and with different bracts, crown, etc.

EXPLANATION OF PLATE.—Fig. 1, branch; fig. 2, leaf showing glands on petiole; fig. 3, flower. (Illustration made from Capt. John Donnell Smith's specimen in Herb. Gray.)



PASSIFLORA NELSONI Rose.

Pseudosmodingium multifolium Rose, sp. nov. FIGURE 6.

Shrub, 2.4 to 6 meters high; leaves clustered at the ends of the young branches, pinnate; leaflets 12 to 15 pairs, linear-lanceolate, granulate-roughened, 20 to 28 mm. long, acuminate, crenate; flowers in panicles clustered at the top of the branches; flowers white; sepals 5, nearly orbicular, about 1 mm. long; petals 5, oblong, obtuse, 2.5 mm. long, strongly veined; stamens 5, short; styles 3, short; fruit strongly flattened and winged, nearly orbicular, slightly broader than high (6 mm. broad), glabrous, shining.

Collected by Mr. E. W. Nelson, at Oaxaca City, altitude 6,000 feet, April 6, 1895 (No. 2542); also by Rev. Lucius C. Smith at Cuesta de Ejutla Nacaltepec, State of Oaxaca, at 2,100 meters, June 1, 1895 (No. 459). Mr. Nelson states that this species was also seen along his route to Tehuantepec.

Three other species are credited to Mexico, two of which were originally described as belonging to the African genus *Smodingium*. Engler, however, has very properly separated them. The genus is new to the National Herbarium.

Pterocarpus acapulcensis Rose, sp. nov.

A tree 7.5 meters high with trunk 4.5 dm. in diameter; leaves large; leaflets 9 to 13, oblong, 3.7 to 8.7 cm. long, glabrous on both sides, green and shining above, pale beneath, shortly acuminate, obtuse at apex or retuse and apiculate; flowers in slender racemes; rachis, pedicels, and calyx with dense blackish pubescence; petals yellow, glabrous; fruit broadly winged, puberulent, nearly orbicular, 5 cm. broad, 6.2 cm. long, somewhat oblique, tapering at base into a slender stipe.

Collected by Dr. Edward Palmer near Acapulco, November, 1894 (No. 83).

Dr. Palmer reports that this is a very handsome tree. It is known to the Mexicans under the name of "drago." It is perhaps nearest *P. drago* L. but differs in the dense pubescence of the inflorescence, large flowers, larger and paler leaflets, etc.

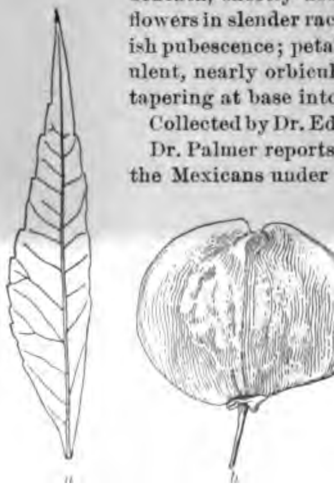


FIG. 6.—*a*, Leaflet of *Pseudosmodingium multiflorum*, scale ½; *b*, samara, scale 1⅓.

Sedum tuberculatum Rose, sp. nov.

Perennial; stems branching and spreading at base, closely set with small red tubercules; leaves spatulate, 6 to 12 mm. long, obtuse, alternate, glabrous; inflorescence of 2 or 3 spreading racemes; pedicels very short or wanting; sepals 5, green, linear, 5 mm. long; petals narrow, 6 to 8 mm. long, white with a green ridge on the back; stamens 10; scales short, truncate; carpels 5, nearly free, tipped with a slender style, in fruit spreading nearly at right angles to the axis; seeds oblong, tuberculate-roughened.

Collected by Mr. E. W. Nelson, 18 miles southwest of the City of Oaxaca, altitude between 2,472 and 3,117 meters, September 10 to 20, 1894 (No. 1329); also by Mr. C. G. Pringle (Nos. 6027 and 6111), Oaxaca, 1894.

Tetrapterys nelsoni Rose, sp. nov.

A high-climbing vine, nearly glabrous; leaves ovate, 12 to 36 mm. long, acute, cordate at base, sessile or on short petioles, shining and nearly glabrous; fruit red; lower wings slightly longer than the upper, 10 mm. long; dorsal rib slightly winged; flowers not seen.

This species appears to be very distinct from the other Mexican species.

Collected by Mr. E. W. Nelson along the road between Nopala and Mixistepec, Oaxaca, March 5, 1895, altitude 804 meters (No. 2431).

Thalictrum grandifolium Rose, sp. nov.

Stems tall, 15 to 24 dm. high, glabrous; leaves large, 3 to 6 dm. long, 4 to 5-ternate; petiole very short with the dilated stipules extending nearly its full length; leaflets petiolulate, large, 2.5 to 5 cm. broad, nearly orbicular in outline, not peltate, cordate at base, terminal ones sometimes rounded, obtusely 3 to 7-lobed; glabrous except a few stout hairs on the veins beneath (as also on the rachis); inflorescence polygamous, 3 to 6 dm. long, nearly naked; filament slender, elongated; anthers linear, apiculate; stigma filiform 6 to 8 mm. long; style persistent, glabrous; akenes flattened, strongly nerved.

Collected by Mr. C. G. Pringle near Cuernavaca, 1896 (No. 6392).

Perhaps nearest *T. grandiflora* Watson.

Wissadula acuminata Rose, sp. nov.

Stems several feet high; leaves lanceolate, somewhat 3-lobed, lateral lobes small, acute, middle lobes long-acuminate, 12.5 to 15 cm. long including the petiole (3.7 to 5 cm. long), deeply cordate at base with an open sinus, crenate, bright green and somewhat pubescent above, pale (nearly white) and densely stellate-pubescent beneath; stipules filiform, deciduous, lower flowers solitary and axillary on elongated peduncles 2.5 cm. long, upper ones in rather dense clusters, the peduncles much shorter; calyx 12 mm. long, cleft below the middle; lobes 5, ovate, long-acuminate; petals yellow; capsule depressed, densely stellate; carpels 5, 6 mm. long, obtuse but shortly apiculate, one-celled but constricted below; lower cavity one-seeded; upper cavity with two collateral seeds; seeds smooth.

Collected by Mr. C. G. Pringle near Tula, State of Hidalgo, October 24, 1896 (No. 6610).

This is near *W. pringlei*, but differs in the shape and color of the leaves, its longer-acuminate sepals, smaller and less aristate carpels, etc.

INDEX.

Page.
Abutilon 133, 134
Amyris 112
Anguria *121*
Apodanthera 121
Asimina 134
Brandegea 115, 119, 120, 121
Brongniartia 134
Bryonia *121*
Bursera 113, 114
Burseraceae 113
Calliandra 135
Cassia 135
Cayaponia 121, *123*
Celastraceae 109
Cologania 136
Combretum 136
Corallocarpus 121
Crotalaria 136
Cucurbita 121
Cucurbitaceae 114
Cuphea 137
Cyclanthera *120*, 121, 122
Doyerea *121*
Drymaria 131, 132, 133
Echinocystis 114, 115, *115*, *116*, *117*, *118*, 119, *119*, *120*
Echinopepon 114, 115, 116, 117, 118, *118*, 119, *119*, *120*
Elaphrium *113*, *114*
Elaterium *116*, *117*, *118*, *120*, 122, *122*
Esenbeckia 110, 111
Fagara *112*
Galactia *136*, 137
Galphimia 137
Gouania 138
Gymnogramme 138
Heliocarpus 125, 126, 127, 128
Hermannia 130, 131
Heteropterys 139

Page.
Hippocratea 109, 110
Hiraea 139
Indigofera 140
Leucaena 140, 141
Luffa 122
Lychnis 141
Marah 115, *117*
Maytenus 109
Megarrhiza *115*
Melothria *120*, 122
Micrampelis 115
Microsechium 122
Mimosa 141
Minkelersia 142
Momordica 122, *122*
Myginda 109
Passiflora 142
Perottetia 110
Phaseolus *142*
Pilocarpus 112
Pittiera 123
Pristimera *116*
Pseudosmodingium 143
Pterocarpus 143
Roseanthus 124
Rutaceae 110
Schizocarpum 124
Sedum 143
Sicyos *115*, *121*, *122*, 124
Tetrapterys 143
Thalictrum 143
Tontellea *110*
Trianosperma *121*
Triphasia 112
Vaseyanthus 115, 119, 120
Wimmeria 129, 130
Wissadula 144
Zanthoxylum 112

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

THE U. S. NATIONAL HERBARIUM.

Vol. V, No. 5.

THE PLANT COVERING OF OCRACOKE ISLAND; A STUDY IN THE ECOLOGY OF THE NORTH CAROLINA STRAND VEGETATION.

BY

THOMAS H. KEARNEY, JR.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., February 28, 1900.

SIR: I have the honor to transmit herewith, for publication a
lume V, No. 5, Contributions from the United States National Her
rium, a manuscript by Mr. T. H. Kearney, jr., assistant botanist
titled The Plant Covering of Ocracoke Island.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

THE U. S. NATIONAL HERBARIUM.

Vol. V, No. 4.

ISSUED OCTOBER 31, 1899.

STUDIES OF MEXICAN AND CENTRAL AMERICAN PLANTS—No. 2. By J. N. ROSE.
TWO NEW SPECIES OF PLANTS FROM THE NORTHWESTERN UNITED STATES. By L. F. HENDERSON.
HESPEROGENIA, A NEW GENUS OF UMBELLIFERAE FROM MOUNT RAINIER. By J. M. COULTER and J. N. ROSE.
THREE NEW SPECIES OF TRADESCANTIA FROM THE UNITED STATES. By J. N. ROSE.
TRELEASEA, A NEW GENUS OF COMMELINACEAE. By J. N. ROSE.
NOTES ON USEFUL PLANTS OF MEXICO. By J. N. ROSE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., May 22, 1899.

SIR: I have the honor to transmit herewith for publication as Contributions from the United States National Herbarium, Volume V, No. 4, six papers, mainly by Dr. J. N. Rose, Assistant Curator, United States National Herbarium, of which the two principal are entitled "Studies of Mexican and Central American Plants," and "Notes on Useful Plants of Mexico."

Respectfully,
FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

Page.

Studies of Mexican and Central American plants—No. 2. By J. N. Rose...... 145
  - Prefatory note........ 145
  - Ferns collected in Mexico by J. N. Rose during the months of August and September, 1897. By George E. Davenport........ 146
  - A proposed rearrangement of the suborder Agaveae........ 151
  - Synopsis of the North American species of Nissolia........ 157
  - Notes on Rutaceae........ 163
    - Zanthoxylum........ 163
    - Miscellaneous species........ 165
  - Notes on Turneraceae........ 165
    - Erblichia........ 165
    - Turnera........ 165
  - Notes on the Mexican species of Clitoria........ 168
  - Notes on Malvaceae and Bombaceae........ 170
    - Abutilon........ 170
    - Anoda........ 172
    - Periptera........ 173
    - Hibiscus........ 174
    - Malvaviscus........ 175
    - Sida........ 175
    - Sphaeralcea........ 177
    - Wissadula........ 177
    - Miscellaneous species........ 179
  - Notes on Passiflora........ 182
  - Synopsis of the North American species of Waltheria........ 183
  - Notes on some Mexican species of Thalictrum........ 185
  - Cedrela or Spanish Cedar........ 189
  - Notes on new or rare Leguminosae........ 191
    - Aeschynomene........ 191
    - Calliandra........ 193
    - Miscellaneous species........ 194
  - Descriptions of miscellaneous new or rare species........ 195

Two new species of plants from the Northwestern United States. By L. F. Henderson........ 201

Hesperogenia, a new genus of Umbelliferae from Mount Rainier. By J. M. Coulter and J. N. Rose........ 203

Three new species of Tradescantia from the United States. By J. N. Rose... 204

Treleasea, a new genus of Commelinaceae. By J. N. Rose........ 207

Notes on useful plants of Mexico. By J. N. Rose........ 209
  - Introductory statement........ 209
  - Cereals and vegetables........ 210
  - Fruits........ 214
  - Beverage plants........ 223
  - Seasoning and flavoring plants........ 226

Notes on useful plants of Mexico—Continued.

Page.

- Medicinal plants 227
- Soap plants 231
- Tanning and dye plants 237
- Fiber plants 239
- Brush and broom plants 252
- Fence and hedge plants 254
- Plants yielding wood 255
- Miscellaneous useful plants 256

ILLUSTRATIONS.

PLATES.

Page.
PLATE XVIII. *Pseudobravoa densiflora* (Robinson & Fernald) ... 155
XIX. *Periptera macrostelis* Rose ... 174
XX. *Passiflora colimensis* Masters & Rose ... 181
XXI. *Thalictrum peltatum* DC ... 186
XXII. *Cuphea trichopetala* Rose ... 196
XXIII. *Cuphea cristata* Rose ... 196
XXIV. *Cuphea koehneana* Rose ... 197
XXV. *Ranunculus madrensis* Rose ... 199
XXVI. *Angelica roseana* Henderson ... 201
XXVII. *Hesperogenia stricklandi* Coult. & Rose ... 203
XXVIII. Fruits and tortilla ... 212
XXIX. Ciruelas—fruit of *Spondias* spp ... 219
XXX. Garambullo, *Cereus geometrizans* Mart ... 220
XXXI. Pulque plant or maguey, *Agave atrovirens* Karw ... 224
XXXII. Pulque plant or maguey, *Agave atrovirens* Karw ... 224
XXXIII. Pulque plant or maguey, *Agave atrovirens* Karw ... 224
XXXIV. Rootstocks of an agave (Manfreda) used for soap ... 234
XXXV. Guererro Indians bringing palm leaves from the Pacific ... 240
XXXVI. Hat braids made from sotol and soyate ... 241
XXXVII. Articles made from sotol and soyate leaves ... 241
XXXVIII. Isote, *Yucca treculeana* Carr., as seen near the Piramide del Sol, northeast of the City of Mexico ... 241
XXXIX. Cogollos of plants furnishing Tampico hemp ... 243
XL. Small bunch of Tampico fiber ... 243
XLI. Small bunch of Tampico fiber ... 243
XLII. Strings made by hand from Tampico fiber ... 243
XLIII. Strings made by hand from Tampico fiber ... 243
XLIV. Mexicans making bagging out of ixtle fiber ... 243
XLV. Mexicans making bagging out of ixtle fiber ... 243
XLVI. Process of twisting ixtle fiber into twine ... 243
XLVII. Lechuguilla plant with burro ... 248
XLVIII. Instruments used in extracting ixtle fiber ... 248
XLIX. Instruments used in extracting ixtle fiber ... 218
L. Articles made from ixtle fiber ... 250
LI. A fiber twister ... 250
LII. Agave fiber and manufacturing implements ... 250
LIII. Cotton fiber and implements ... 251
LIV. Brushes of palm leaf and grass ... 252
LV. Hairbrushes made from Tampico fiber ... 252
LVI. Brushes made from several kinds of fibers ... 252
LVII. Hairbrush made from a fruit of *Cereus pecten-aboriginum* Engelm. 253
LVIII. *Cereus pecten-aboriginum* Engelm ... 254

Page.
Plate LIX. Organo, *Cereus marginatus* DC., used for fences near the City of Mexico 255
LX. Organo, *Cereus marginatus* DC., used for fences near the City of Mexico 255
LXI. Wooden articles 256
LXII. Sacred cactus, *Mamillaria senilis* Lodd 258
LXIII. Vessels made from Crescentia fruits 259
LXIV. Gourd used for a water vessel 259

TEXT FIGURES.

Fig. 7. Flowers of *Polianthes tuberosa* L 154
8. Flowers of *Polianthes* sp 154
9. Flowers of *Polianthes* sp 154
10. Flowers of *Bravoa geminiflora* Lex 154
11. Flowers of *Prochnyanthes viridescens* Wats 155
12. Flower of *Manfreda virginica* Salisb 155
13. Manfreda seedling 155
14. Manfreda bulb, cross section 155
15. Flower of *Agave americana* L 156
16. Agave seedling 156
17. *Nissolia wislizeni* Gray 158
18. *Nissolia schottii* (Torr.) Gray 159
19. *Nissolia platycalyx* Wats 159
20. *Nissolia pringlei* Rose 160
21. *Nissolia diversifolia* Rose 160
22. *Nissolia hirsuta* DC 161
23. *Nissolia dodgei* Rose 161
24. *Nissolia multiflora* Rose 161
25. *Nissolia laxior* (Robinson) Rose 162
26. *Nissolia nelsoni* Rose 162
27. *Nissolia fruticosa* Jacq 163
28. *Anoda hastata* Cav 172
29. *Periptera periptera* (Sims) Rose 173
30. *Gronovia longiflora* Rose 198
31. Huamuchil, *Pithecolobium dulce* Benth 216
32. *Cereus pecten-aboriginum* Engelm 254

STUDIES OF MEXICAN AND CENTRAL AMERICAN PLANTS—NO. 2.

By J. N. Rose.

PREFATORY NOTE.

To the collections of Palmer, Pringle, and Nelson, upon which the first part of this paper was chiefly based, is to be added my own collection made in Mexico in 1897. This collection embraces 2,569 numbers (1,200 to 3,768, inclusive) and comes from fifteen States and Territories, but chiefly from Sinaloa, Territorio de Tepic, Durango, Jalisco, and Zacatecas. I was four months in making this collection (June to September), and I was especially fortunate in duplicating at the type localities many species which have only once before been collected. This was particularly true of some of Palmer's species from Guaymas and La Paz, Seemann's species from the Sierra Madre, Hartweg's species from Bolanos and vicinity, and Palmer's and Pringle's species from Guadalajara and vicinity. The collection is especially rich in Umbelliferae, among which an unusual proportion are undescribed; in Agave, of which genus it contains 75 sheets, while in the National Herbarium there are only 38 sheets from Mexico; and in Orchidaceae, with 67 sheets, Compositae, with 271 sheets, and Quercus, with 47 sheets.

Besides the herbarium specimens, a very respectable collection of roots, bulbs, seeds, etc., was sent to the Botanical Garden.

Of these the following have flowered since arriving in Washington:

Mr. Rose's plants which have flowered in Washington.

Name.	Date of flowering.	Catalogue number.
Minkelersia biflora Hemsley	Mar., 1898	2696
Oxalis sp	Feb., 1898	1508
Tradescantia sp. nov	June 15, 1898	2761
Portulaca stelliformis DC	June 28, 1898	1848
Zephyranthes sp. nov	July, Aug. 15, 1898	1494
Treleasea tumida (Lindl.) Rose	July 13, 1898	2660
Iris sp. nov	July, 1898	2139
Cuphea llavea Lex	Aug., 1898	3767
Hymenocallis sp	Aug., 1898	3768
Manfreda sp	Aug., 1898	3765
Bidens palmeri Watson	Oct., 1898	3066

In the preparation of this paper I am especially indebted to Dr. B. L. Robinson, curator of the Gray Herbarium, for the loan of the specimens of Nissolia, Waltheria, and of miscellaneous specimens in his charge; to Mr. J. M. Greenman, of the Gray Herbarium, for various critical notes and comparison of specimens; to Mr. John Donnell Smith, of Baltimore, for the loan of his specimens of Waltheria and Nissolia; to Mr. E. G. Baker, of the British Museum, who has verified most of my identifications in the Malvaceae and has assisted in the preparation of some of the notes and technical descriptions. Besides this assistance, Mr. George E. Davenport, of Medford, Mass., has kindly determined my collection of ferns. Mr. William R. Smith, superintendent of the Botanic Garden at Washington, has courteously placed at my disposal the valuable facilities of that institution.

FERNS COLLECTED IN MEXICO BY J. N. ROSE DURING THE MONTHS OF AUGUST AND SEPTEMBER, 1897.

By GEORGE E. DAVENPORT.[1]

ACROSTICHUM.

Acrostichum conforme Sw. Syn. Fil. 10, 192, *t. 1, fig. 1.* 1806.

Santa Teresa, Territory of Tepic, August 12 (No. 2215).

A small plant with ovate-elliptical fronds, apparently identical with *A. obtusifolium* Brack. Heller's No. 2808 in the Gray Herbarium at Cambridge, Liebmann's No. 7, and Pringle's No. 4916, referred to this species, have a more delicate, slender rootstock, and may be different.

The species is an extremely variable one, and some of the smaller forms are difficult to place without the aid of a good series of specimens.

Acrostichum pilosum H. B. K.; Willd. Sp. Pl. **5**: 103. 1810.

Sierra de los Morones, near Plateado, State of Zacatecas, September 1, 1897 (No. 2728); also Santa Teresa, August 12, 1897 (No. 2210).

The latter consists of smaller plants, quite different in appearance, but apparently the same as No. 2728; the scales of the rootstock, stipes, and costæ are identical, as is the form of the lamina. The two are not safely separable.

Acrostichum spathulatum Bory, Voy. Mers d'Afriq. **1**: 363, *t. 20, fig. 1.* 1804.

Santa Teresa, Territory of Tepic, August 12, 1897 (No. 2202).

Specimens all sterile and not as fibrillose as Pringle's No. 4964 from San Felipe, Oaxaca, 1894, or No. 2606 from near Guadalajara, 1889, but not safely placed elsewhere. The specimens closely resemble Bourgeau's No. 3072 from Orizaba, 1886, in the Gray Herbarium (Ex. Paris Mus.), labeled *A. jamesoni* Hook., but Hemsley[2] refers that to *A. spathulatum*, while Moore places it under *A. piloselloides* Presl, which Baker and Hemsley both give as a synonym for *spathulatum*. Fournier[3] and Fée[4], however, retain Hooker's *jamesoni*, and the former cites Bourgeau's No. 3072. The whole group which is composed of these small Acrostichums seems to have been much confused or misunderstood, as is evidenced by the long list of synonyms in Moore's Index Filicum, 363, 364, under Elaphoglossum.

---

[1] The bibliography of this paper has been modified so as to conform to the usage of this publication. Mr. Davenport has kindly consented, for the sake of uniformity, to the use of the name Dryopteris, although he himself still uses the name Aspidium.

[2] Biol. Centr. Am. **3**: 689.

[3] Mex. Crypt. 68.

[4] Acros. *t. 14, fig. A.*

ADIANTUM.

Adiantum patens Willd. Sp. Pl. **5**: 439. 1810.

Foothills, Sierra Madre, near Colomas, State of Sinaloa, July 16 (No. 3250).

Specimens somewhat lax, but with the characteristic reddish, pubescent stipes and rachises.

Adiantum thalictroides Willd.; Fée, 9e Mém. Foug. 6. 1857.

Sierra Madre, near Santa Teresa, August 12 (No. 2204.)

From the frequency with which this lovely Adiantum is turning up in collections it must be quite plentiful. It is certainly a very beautiful fern, and in some early stages of its development its very symmetrical involucres are made more attractive by a pinkish coloring of the center.

The species resembles somewhat the more branching forms of *A. capillus-veneris*, but may readily be distinguished by the character of its sori. These are remarkably uniform in size and shape, reniform, placed within the margin of a deep, roundish sinus, the extended edges of which form a semicircle, with a small eyelet hole that gives to the whole frond, when held against the light, the appearance of being perforated all around the margins. Hemsley[1] places this under *A. aethiopicum* as a synonym, but I doubt if any well-authenticated specimens of that species have ever been found in North America.

DRYOPTERIS.

Dryopteris ampla (Mett.) Gilbert, Bull. Torr. Club, **25**: 599. 1898. *Aspidium amplum* Mett. Pheg. & Asp. no. 170, excl. syn.

Pedro Paulo, Tepic, August 13 (No. 3327).

I am not sure of this. The specimens consist of two sterile fronds only, but with a portion of the caudex showing an entangled mass of long, linear-lanceolate, silky scales which envelop the base of the stipe, and which, as well as the fibrillose scales on the rachises, seem to make the determination fairly certain. They also agree with some fertile fronds of this species recently collected in the valley of Cordoba (December, 1897) by C. Gonzatti and V. Gonzalez. (No. 594.)

Dryopteris contermina (Willd.) Kuntze, Rev. Gen. Pl. **2**: 812. 1891. *Aspidium conterminum* Willd. Sp. Pl. **5**: 249. 1810.

Small plants from Pedro Paulo, Tepic. August 12 (No. 3330).

Dryopteris martinicensis (Spreng.) Kuntze, Rev. Gen. Pl. **2**: 812. 1891. *Aspidium martinicense* Spreng. Anleit. **3**: 133. 1804. *Aspidium macrophyllum* Sw. Syn. Fil. **43**, 239. 1806.

Near Colomas, July 20 (No. 1778). Young plants, but with the usual character of this striking and unmistakable species.

Swartz cites Sprengel's name as a synonym and Dr. Kuntze takes it up under *Dryopteris*. Beyond this I find no evidence to show that the plants are identical.

Dryopteris parasitica (L.) Kuntze, Rev. Gen. Pl. **2**: 811. 1891. *Polypodium parasiticum* L. Sp. Pl. **2**: 1090. 1753. *Polypodium molle* Jacq. Icon. Rar. *t. 640*. 1781. *Aspidium molle* Sw. Syn. Fil. 49. 1806. *Aspidium parasiticum* Sw. l. c. *Nephrodium molle* Desv. Mem. Soc. Linn. **6**: 258.

Pedro Paulo, August 3 (Nos. 3325 and 3326). Specimens unusually fresh, bright green, and perfect in every way.

Linnæus appears to have founded his species on the figure and description of Rheede,[2] but neither his own description, nor that of Rheede, nor the figure, makes it clear to me that *P. parasiticum* L. and *A. molle* Sw. are identical. Rheede's figure and description point to a very much larger plant in every way than our *molle*, and in view of the uncertainty surrounding Linnæus's species I think it would be better to retain the name *molle,* which has not only been established for more than a century, but which has the added merit of admirably expressing the special character of this fern.

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[1] Biol. Centr. Am. **3**: 607.

[2] Hortus Indicus Malabaricus, 35, *t. 17*. 1703.

Dryopteris patula (Sw.) Underw. Our Native Ferns, ed. 4, 117. 1893. *Aspidium patulum* Sw. Vet. Akad. Handl. **1817**: 74.

Near Santa Teresa, August 12 (No. 2203); also same locality, August 10 (No. 3415), small form; and variety *chaerophylloides* (Moritz) Baker from road between Colotlan and Bolaños, Jalisco, September 7 to 9 (No. 2837).

ASPLENIUM.

Asplenium monanthemum Willd. Sp. Pl. **5**: 322. 1810.

Near Santa Teresa, August 12 (No. 2209); also on the Sierra de los Morones, near Plateado, Zacatecas, September 1 (No. 2726). Specimens monosorous.

Asplenium parvulum Mart. & Gal. Mem. Acad. Brux. **15**: 60, *t. 15, f. 3.* 1842.

Near Santa Teresa, August 12 (No. 2201). Plants small but characteristic. Fournier refers this to *A. resiliens* Kuntze, and Baker, in the Synopsis Filicum, placed it under *A. trilobum* Cav., while Hemsley[1] gives it as a synonym for *A. trichomanes* L. Its affinity, however, is more nearly to *A. ebeneum* Ait. under which Hooker placed it as a variety (var. *minor*), but it has so many distinctive characters that I think Professor Eaton was right in maintaining Martens and Galeotti's name, a position which Mr. Baker himself has more recently taken in his "Summary of New Ferns," Annals of Botany, vol. 6.

CHEILANTHES.

Cheilanthes aurantiaca Moore, Synopsis, 38; Index Fil. 235. *C. ochracea* Hook. Sp. Fil. **2**: 114. 1858.

Near Santa Teresa, August 7 (No. 3427). Not seen in collections very often and apparently not a very common fern. Fournier places it in Fée's *Aleuritopteris* as *A. lutea*; *Pteris lutea* Cav.; *Pteris aurantiaca* Cav. Praelect. 266. 1801.

Cheilanthes lendigera Sw. Syn. Fil. 128. 1806.

Mountains west of Bolaños, September 16 (No. 3717).

CYSTOPTERIS.

Cystopteris fragilis (L.) Bernh. Schrad. Neues Journ. Bot. **1**, pt. 2: 26, *t. 2, fig. 9* (or *7?*). 1806. *Polypodium fragile* L. Sp. Pl. **2**: 1091. 1753.

Santa Teresa, August 12 (Nos. 2206, 2207); well-developed plants of the common form.

NOTHOLAENA.

Notholaena ferruginea Desv. Journ. Bot. Appl. **1**: 92. 1813.

Near Plateado, Zacatecas, September 4 (No. 2747); specimens unusually fine.

Notholaena nivea Desv. Journ. Bot. Appl. **1**: 93. 1813.

Sierra Madre west of Bolaños, Jalisco, September 16 (No. 3715); specimens large and fine. Near Plateado, Zacatecas, September 4 (No. 3740); smaller plants near variety *dealbata* Davenport.

Notholaena schaffneri mexicana Davenport, Gard. and For. **4**: 519. 1891.

Near Monte Escobedo, Zacatecas, August 17 (No. 2262); also Bolaños, Jalisco, September 10 to 19 (No. 2910).

The species was originally described by Fournier,[2] from specimens collected in the mountains of San Miguel, September, 1876, by Schaffner. In June, 1890, Mr. G. C. Nealley collected in western Texas a few specimens of a fern which Mr. Henry E.

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[1] Biol. Centr. Am. **3**: 610.

[2] Bull. Bot. Soc. de France, **27**: 328.

Seaton published and described in Contributions from the United States National Herbarium[1] as *Notholaena nealleyi*, and in February, 1891, I published in the Botanical Gazette some observations on the same in comparison with Pringle's No. 1864, from near Guadalajara, Mexico, 1888, in which I referred the latter to *N. nealleyi* as variety *mexicana*. Subsequently Dr. Underwood established the identity of Nealley's plant with Schaffner's, and the above result was published in my notes on Pringle's ferns in Garden and Forest.[2] I am not sure now that it is best to maintain the variety, although the characters which I pointed out in the Botanical Gazette seemingly continue to hold good, and the specimens which Dr. Rose has collected are fine examples of the form.

Notholaena sinuata Kaulf. Enum. 135. 1824.

On the road between Colotlan and Bolaños, Jalisco, September 7 to 9 (No. 2824).

PELLAEA.

Pellaea angustifolia (H. B. K.) Baker, Syn. Fil. 150. 1868. *Allosorus angustifolius* Presl, Tent. Pterid. 152. 1836. *Cheilanthes angustifolia* H. B. K. Nov. Gen. et Sp. 1: 21. 1815.

Near Santa Teresa, August 12 (No. 3416); Dolores, August 6 (No. 3366). Bits in envelope are part this, and part No. 1808 (*P. rigida*). Above Colomas, foothills of Sierra Madre, State of Sinaloa, July 19, form approaching variety *cuneata* Baker (*Cheilanthes cuneata* Link) (No. 1809, a and b). Also Santa Teresa, August 12 (No. 2211 in part, and in part specimens by me marked a, b, and c), the form *P. marginata pyramidalis* Baker.

The series shows much variation and is an unusually interesting one.

Pellaea cordata (Cav.) J. Smith, Cat. Kew Ferns, 4. 1845. *Pteris cordata* Cav. Prael. **1801**: No. 662. 1801. *Allosorus cordatus* Presl, Tent. Pterid. 153. 1836.

Near Plateado, Zacatecas, September 4 (No. 2795).

The specimens show considerable variation in the shape of the pinnules, some of the younger ones being distinctly cordate, and older ones more like variety *sagittata*.

Pellaea marginata Baker, Syn. Fil. 151. 1868.

Santa Teresa, August 12 (No. 2208). Fronds somewhat deltoid in outline, and near normal forms of the species. Also between Dolores and Santa Gertrudis, Tepic, August 7 (No. 3373). Plants very tall, approaching and perhaps best called variety *pyramidalis* (*Cheilanthes pyramidalis* Fée), but not pendent as is usual in that form. The specimens are elegant and so different in appearance from usual forms as almost to suggest a new species.

Pellaea rigida (Sw.) Hook. Sp. Fil. **2**: 144. 1858. *Pteris rigida* Sw. Syn. Fil. 104. 1806.

Foothills, Sierra Madre, above Colomas, Sinaloa, July 19 (No. 1808). Small plants and very pubescent. A part of this in envelope with No. 3416.

Pellaea seemanni Hook. Sp. Fil. **2**: 141, *t. 117* B. 1858.

Between San Blascito and Aguacata, Tepic, August 5 (No. 3346). Dr. Rose's specimens are characteristic of this very distinct species (so admirably represented by Hooker's figure) and strengthen a suspicion which I have long held, that two distinct species have been referred to this name in our herbaria.

Pellaea ternifolia (Cav.) Fée, Gen. Fil. 129. 1850–52. *Pteris ternifolia* Cav. Praelect. **1801**: No. 657. 1801.

Near Plateado, September 4 (No. 2792); also near Santa Teresa, August 10 (No. 3403). Specimens all good, but the latter especially fine.

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[1] Vol. 1, p. 61.

[2] Vol. 4, p. 519.

PHEGOPTERIS.

Phegopteris rudis Mett. Fil. Hort. Lips. 83. 1856.

Near Santa Teresa, August 12 (No. 2213).

POLYPODIUM.

Polypodium angustifolium Sw. Fl. Ind. Occ. **3**: 1627. 1806.

Foothills Sierra Madre, Sinaloa, near Colomas, July 16 (No. 1691); also between Dolores and Santa Gertrudis, Tepic, August 7 (No. 2059). Sori irregularly uniserial, but lamina broad enough (¼ to ⅜ inch) for type.

Polypodium aureum L. Sp. Pl. **2**: 1087. 1753.

Sierra Madre, west of Bolaños, Jalisco, September 15 to 17 (No. 2968). Small plants, scarcely, or very slightly, glaucous beneath, one young state three-lobed and fertile. Probably Fée's *Chrysopteris trilobata* mentioned[1] as a dwarf form with three lobes was founded on some such specimen. The specimens show free veinlets within the areolæ and must be considered as young plants of the species. With this is another sheet, not numbered (stamped) and without special data, but ticketed "No. 5c from Guanuato, A. Dugès." It contains a single frond about 10 inches tall with a terminal lobe and five pairs of lateral ones, glaucous beneath and without free veinlets. The specimen, therefore, is the variety *areolatum* (H. B. K.) Baker. But a variety based on such unsubstantial differences is scarcely worth maintaining.

Polypodium furfuraceum Schlecht. Linnaea, **5**: 607. 1830.

Between Rosario and Colomas, July 13 (No. 1642).

This is one of the most interesting Polypodiums that I know of, on account of the singularly beautiful and varied scales with which the fronds are everywhere clothed. *P. skinneri* Hook. resembles it very much, but is less densely clothed with scales, and has a system of free veinlets, while those of the present species are forked.

Polypodium lanceolatum L. Sp. Pl. **2**: 1082. 1753.

Near Colotlan, August 29 (No. 3609). Weather-beaten, shrunken, small fronds, but characteristic of this species. Also west of Bolaños, September 16 (No. 3716), small plants, some fronds lobing slightly.

Polypodium pectinatum L. Sp. Pl. **2**: 1085. 1753. Non herb., nec auct.

Foothills Sierra Madre, near Colomas, Sinaloa, July 18 (No. 3201).

I place the specimens here on account of the villous stipe and rachises, but the plants are small and might pass for *P. elasticum* Rich., a species doubtfully distinct. Both have forked venation, with the lower pinnæ reduced, the other characters being equally variable in both species, which appear to differ only in size.

Polypodium subpetiolatum Hook. in Benth. Pl. Hartw. 54. 1840.

Near Santa Teresa, August 12 (No. 2205).

Polypodium thysanolepis A. Br.; Klotzsch, Linnaea, **20**: 392. 1847.

West of Bolaños, September 16 (No. 3710); Sierra Madre, Zacatecas, August 18 (No. 2399)—all very small, young plants. Also near Plateado, September 4 (No. 2797), plants more mature.

PTERIS.

Pteris aquilina lanuginosa (Bory) Hook. Sp. Fil. **2**: 196. 1858. *Pteris lanuginosa* Bory; Willd. Sp. Pl. **5**: 403. 1810.

Near Santa Teresa, August 12 (No. 2212).

WOODSIA.

Woodsia mexicana Fée, 7^{e} Mém. 66, *t. 26, figs. 3–5.* 1854–1857.

West of Bolaños, September 16 (No. 3719); specimens narrow and slender. Also a larger form from near Plateado, Zacatecas, September 4 (No. 2796).

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[1] Baker, Syn. Fil. 347.

Fournier cites Robert Brown[1] for this species and gives it as a synonym for *W. mollis* J. Smith, as does Hemsley[2] also; but the very marked difference in the structure of the involucres is of itself a sufficiently good character to separate the two—*W. mexicana* and *W. mollis*—absolutely.

WOODWARDIA.

Woodwardia radicans J. E. Smith, Mem. Acad. Tor. **5**: 412. 1793.

Near Santa Teresa, August 12 (No. 2214). The American forms of this species have been considered as distinct species, or at least as varietal, but there appears to be no really good reason for separating them from the European.

A PROPOSED REARRANGEMENT OF THE SUBORDER AGAVEAE.

The accepted distinctions separating Agave and its allies are not altogether satisfactory.

I am led to propose the following arrangement after a study extending over several years. Besides the National Herbarium, I have had almost daily access to the rich collections of the Washington Botanical Garden, as well as four months' study in Mexico, where I had an opportunity of seeing thousands of these plants growing under their natural conditions. In this connection I ought to state that I brought back 98 specimens for the herbarium and 40 living plants, more than half of the species represented by the latter being new to cultivation. In Mexico I had great difficulty in determining the genus to which a number of my plants of this group belonged. For instance, I found that Polianthes was said to have a "lax simple spike," Prochnyanthes a "lax raceme," and Bravoa an "inflorescence laxly spicate or racemose." Prochnyanthes was found, however, with nearly sessile flowers, while Polianthes has often shortly pediceled flowers or even a paniculate inflorescence. In fact, there is no difference in the inflorescence of these three genera; the roots, stems, leaves, are also all on the same plan, and the habit and habitat are similar. The only grounds for generic separation lie in the perianth, and I have sometimes felt that these were not sufficient. Indeed, any such distinction seems to break down between the first and last. The close relationship of these three genera has been observed by others. Mr. Baker arranged them one after the other, although he has not brought out clearly the real difference that exists between them, and places Prochnyanthes between Polianthes and Bravoa. It must be remembered, however, that most of the species have heretofore been known only from single specimens. The point at which my results seem to differ most from those of others is in the placing of the herbaceous species of Agave nearer the above than to Agave proper. It is remarkable that the herbaceous Agaves have not been united into an independent genus before.

It is true that single species, four in all, have been made the types of as many distinct genera, but the peculiar and uniform group composed of some 15 species has not been segregated. The relationships of these species, however, have not been unobserved.[1] Some Manfredas (at least one) have been described as Polianthes, and two Agaves (§ Manfreda) have been called *A. polianthoides*. Baker has also called attention to their close relationship with Polianthes and Bravoa. I find that, except in the flowers, these herbaceous Agaves have all their relationships with Polianthes and its allies, which they resemble, namely, in their herbaceous habit, their bulbose base appearing annually from thickened rootstocks, their short-lived leaves, and their inflorescence. They differ from Polianthes in having their flowers solitary instead of in twos, but in this respect they agree with one or two reputed species of Bravoa (*B. singuliflora* and *B. densiflora*). I have studied seedlings of only one species, but have no doubt that the development of all is similar. In the species studied a true bulb was formed the first year. In the case of several species which I collected in Mexico I found that the flowering stalks came from bulbs crowning short rootstocks. In the case of Agave a true caudex is developed the first year, which persists throughout the life of the plant.

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[1] In Wall. Pl. Asiat. Rar. **1**: 42.

[2] Biol. Cent. Am. **3**: 595.

Unfortunately little attention has been paid by collectors to those parts of the plant which grow beneath the surface of the ground, and as a result many erroneous statements have crept into print. For instance, in the original description of Prochnyanthes it is stated that it has a "short, thick, erect bract-covered caudex," and in another part of the same description it is said to have a "short caudex covered with broad clasping leaves," while Bravoa is said to have the "rootstock tuberous" and some species to have the "tubers oblong, with tunics slitting into fine fibers at the top," etc.

In Mexico, where I examined many specimens, I found practically the same structure in the ground parts of Bravoa, Prochnyanthes, Polianthes, and Agave § Manfreda. A description of Prochnyanthes is a description of all the others except in some minor details. In this genus I found:

(1) That the rootstock is small and covered with small bracts. (In some species of Agave this rootstock becomes of great size, and it is that which furnishes much of the *amole* of the Mexicans.)

(2) That from the rootstock descend a number of spindle-shaped fleshy roots.

(3) That the rootstock is crowned by a well-developed tuber with regularly concentric layers, and the top of the tuber crowned with a cluster of fibers, which are the remains of the old leaves.

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[1] Hartweg (Trans. Hort. Soc. 3: 117, 1848) speaks of one of these plants as follows: "The soap plant, *Agave saponaria*, was found throwing up its flower stem like a tuberose, to which, in fact, it bears much resemblance."

The following table shows the more recent treatments of this subfamily:

Various arrangements of Agaveae.

Bentham and Hooker, 1883.	Pax in Engler and Prantl, 1887.	Baker, 1888.	Proposed arrangement, 1899.
Polianthes.	Bravoa.	Polianthes.	
Bravoa.	Polianthes.	Prochnyanthes (1887)	Prochnyanthes.
		Bravoa.	Polianthes. *Bravoa.*
Beschorneria	Beschorneria	Beschorneria.	Pseudobravoa (below).
		Doryanthes.	Manfreda (1866). *Alibertia* (1882). *Leichtlinia* (1893). *Delphinoa* (1897).
Agave	Agave	Agave *Manfreda.*	Agave.
Furcraea	Furcraea	Furcraea	Furcraea.
			Beschorneria.
Doryanthes	Doryanthes		Doryanthes.

In the accompanying key Furcraea, Beschorneria, and Doryanthes are omitted, as it is my desire here to bring out the difference between Manfreda and its allies.

KEY TO MANFREDA AND RELATED GENERA.

A. *Plantlets forming the first year true bulbs; plants appearing annually from bulbs which crown more or less thickened rootstocks; dying down annually; leaves comparatively thin, neither spine-edged nor spine-pointed; inflorescence a simple lax raceme or spike; flowering annually.*

B. *Flowers normally in pairs; perianth always curved; filaments equal, not folded in the bud; anthers included.*

C. *Perianth not abruptly curved or dilated at the middle; stamens inserted far above the curve in the perianth tube (with some exceptions); filaments mostly very short; ovary usually free at the apex.*

Polianthes L. BRAVOA Llav. & Lex.

CC. *Perianth abruptly dilated and curved at the middle; stamens inserted below the curve in the perianth tube; filaments longer than in the last.*

Prochnyanthes Wats.

Hardly to be distinguished from Polianthes except in the perianth.

BB. *Flowers (normal) always solitary; stamens folded in the bud.*

D. *Stamens included; inflorescence dense.*

Pseudobravoa (Bravoa in small part).

DD. *Stamens exserted; inflorescence open.*

Manfreda Salisb. emended (Agave § Manfreda).

a. *Perianth straight.*

Subgenus EUMANFREDA.

b. *Perianth strongly curved.*

Subgenus PSEUDOMANFREDA.

AA. *Plantlets forming the first year a distinct caudex; plants persisting from year to year and having a more or less distinct stem; leaves persisting for several, often many, years, usually thick, fleshy, spiny-edged, the spines pointed; inflorescence either a dense cylindrical spike with flowers normally in twos or a large panicle with candelabra-like branches; flowering usually after a long interval of growth, sometimes but once, in other species occasionally, in one annually; perianth tube straight; stamens folded in bud.*

Agave (for the most part).

The genera as here received may be noted as follows:

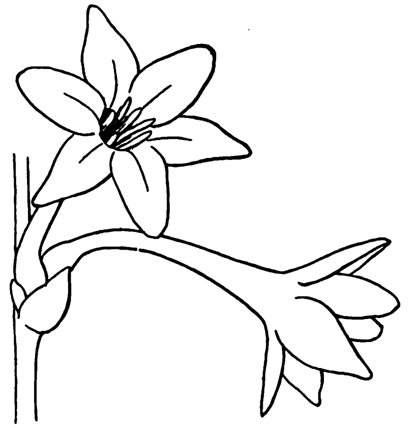


FIG. 7.—Flowers of *Polianthes tuberosa*, natural size.

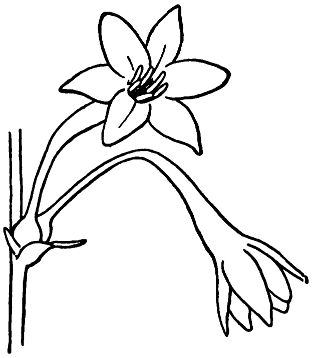


FIG. 8.—Flowers of *Polianthes* sp., natural size.

Polianthes L. Sp. Pl. **1**: 316. 1753. FIGURES 7 to 9.

Type, *P. tuberosa* L.

P. tuberosa has been cultivated for four hundred years, and the real home of the species is unknown. It has been assigned both to Asia and America. Linnæus says, in Species Plantarum, "Habitat in India." Its allies are mostly Mexican, although it does not seem to have had its origin in any of the wild species known to me. It has also been reported from the higher Andes of South America. To Polianthes I would refer

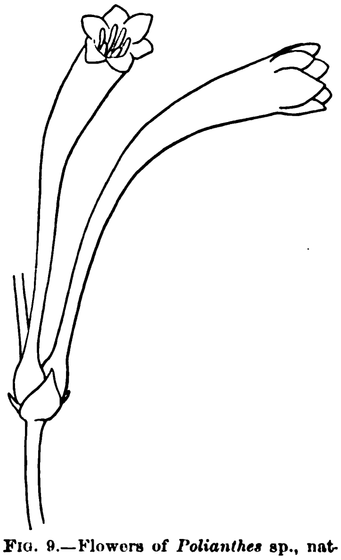


FIG. 9.—Flowers of *Polianthes* sp., natural size.

BRAVOA Llav. & Lex. (for most part) Nov. Veg. Desc. fasc. **1**: 6. 1824. FIGURE 10.

Type of the genus, *Bravoa geminiflora* Lex. in Llav. & Lex., l. c.

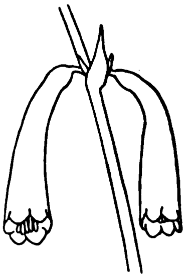
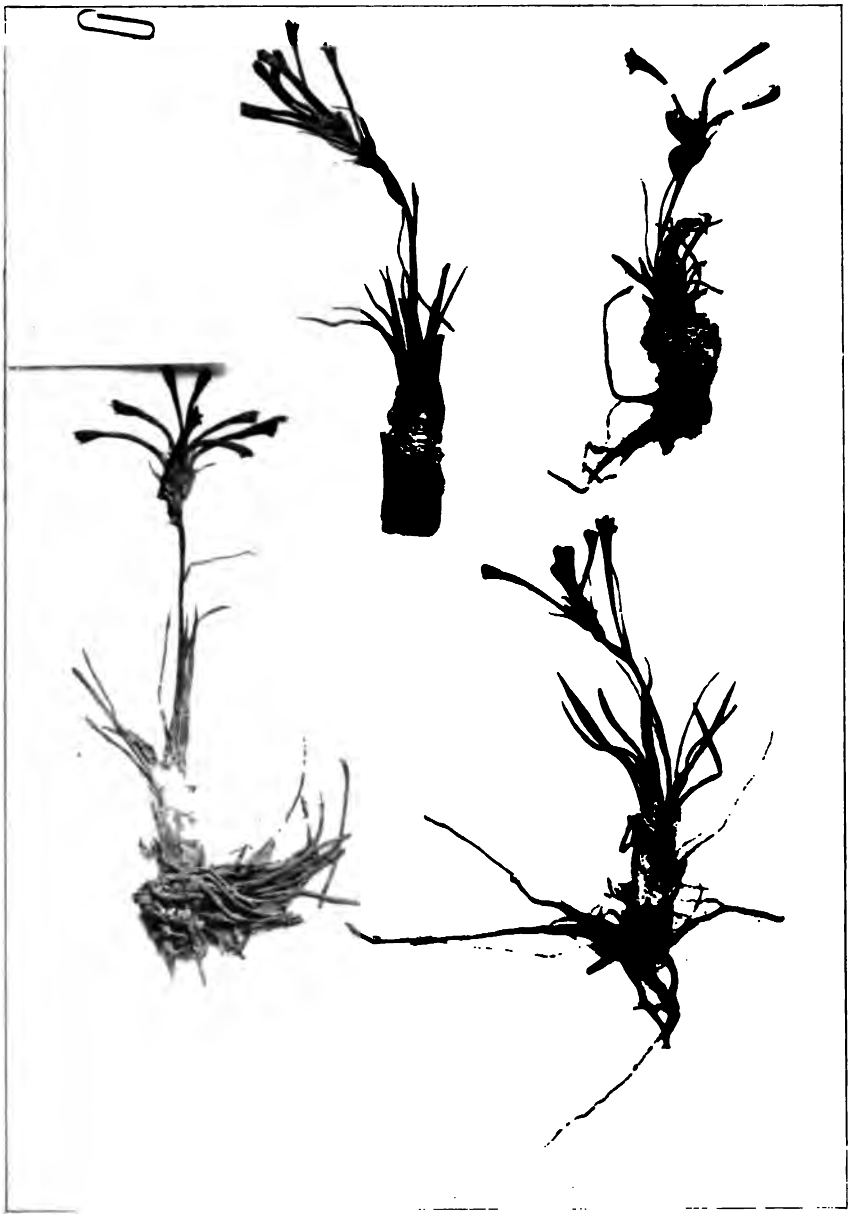


FIG. 10.—Flowers of *Bravoa geminiflora*, natural size.

Bravoa geminiflora is quite unlike *P. tuberosa* in its short, red, cylindrical perianth tube, and were these species the only representatives of these genera the two might be kept distinct. Taking into consideration other species, however, I can not find any character or group of characters by which they can be distinguished. The best character which I find to separate the several species of this group is the degree of elongation and the manner of the bend-



PSEUDOBRAVOA DENSIFLORA (Robinson & Fernald) Rose.

ing of the tube, but this throws *P. tuberosa* and *B. geminiflora* into the same subgroup. As I understand the genus, it is composed of 9 or 10 species.

Prochnyanthes Wats. Proc. Am. Acad. **22**: 457. 1887. FIGURE 11.

Type of genus, *P. viridescens* Wats., l. c.

This genus was established by Dr. Sereno Watson in 1887 upon plants brought back by Dr. Edward Palmer from near Guadalajara. The species has been supposed to be known only from this region. I found it to be very common, however, in the Sierra Madre, and specimens were brought back from the Territorio de Tepic and the States of Durango, Zacatecas, and Jalisco. These specimens show considerable departures from the type, but I have been compelled to consider them all as forms of a widely varying species.

Living specimens were brought home, and these are the first which have been reported in cultivation.

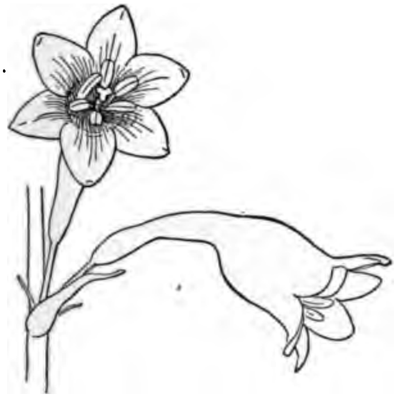


FIG. 11.—Flowers of *Prochnyanthes viridescens*, natural size.

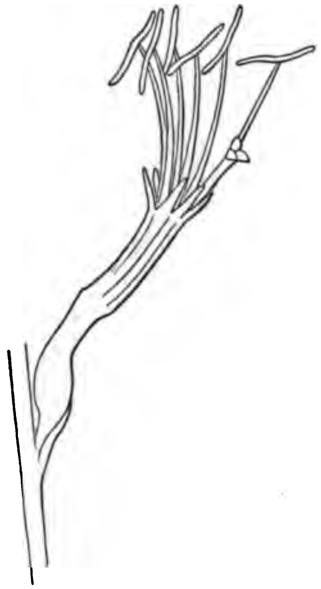


FIG. 12.—Flower of *Manfreda virginica*.

Pseudobravoa Rose, gen. nov. PLATE XVIII.

Type, *Bravoa densiflora* Robinson & Fernald, Proc. Am. Acad. **30**: 122. 1894.

The genus differs from Bravoa and Polianthes in its short, dense spike of flowers, which are solitary in the axils of long-attenuate bracts. The flowers are yellow, very long funnel form, at first erect, becoming somewhat curved, but never abruptly bent or abruptly dilated. Stamens inserted high up in the tube; anthers included. Low, nearly acaulescent plants with loosely coated bulbs, the rootstocks very small or wanting. The only species is *Pseudobravoa densiflora* (Robinson & Fernald).

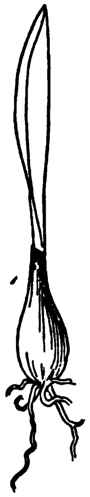


FIG. 13.—Manfreda seedling, natural size.

Manfreda Salisb. Gen. Pl. Fragm. 78. 1866. FIGURES 12 TO 14.

Type of the genus, *Manfreda virginica* (L.) Salisb. l. c. *Agave virginica* L. Sp. Pl. **1**: 323. 1753.

This genus was established by Salisbury in 1866, but has never come into use. There has been, however, a quite general agreement that these species form a very unique section of Agave. Baker says, in speaking of Manfreda: "These form a very distinct group, worthy, I think, of separation

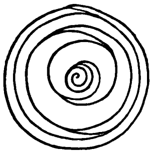


FIG. 14.—Manfreda bulb, cross-section—scale of 3.

into a subgenus, in which habit and leaf characters and short life duration run parallel with a well-marked distinctive type of inflorescence." It may be questioned whether these characters may not properly be considered generic. There are certainly no equally good grounds for keeping Bravoa or Prochnyanthes from Polianthes. Added to these characters are the peculiar rootstock and bulb of Polianthes and its allies.

Baker recognizes 12 species in Agave § Manfreda, but this number will be doubled when Mexico has been better explored.

Agave L. Sp. Pl. **1**:323. 1753.

FIGURES 15, 16.

Type, *A. americana* L., l. c.

Linnæus gave four species of Agave in the first edition of the Species Plantarum, of which two are here of interest, viz, *A. americana* and *A. virginica*. The former is to be taken as the type of the genus. Linnæus says: "Habitat America calidiore."

Known species more than 100.

The following other genera have been taken out of Agave, but appear to be identical with Manfreda:

ALIBERTIA Marion, Rev. Hort. Bouch. Rhône, November, 1882.

Type, *A. intermedia* Marion, l. c.

This is also *Agave alibertii* Baker, Gard. Chron. N. S. **19**:176. 1883.

LEICHTLINIA Ross, Delect. Sem. Panorm. 48. 1893.

Type, *Agave protuberans* Engelm. in Baker, Handbook Amaryll. 197. 1888.

We have a duplicate in the National Herbarium. This form, of course, should come out of Agave; but I should not separate it from Manfreda, for I do not consider the slight projection of the ovary into the perianth tube of sufficient importance to base a genus upon. This character is of no value in Polianthes. Other species of Manfreda probably possess the same character. The fruit of *Agave maculosa* has a slender beak, but I am not sure whether or not it is free from the perianth.

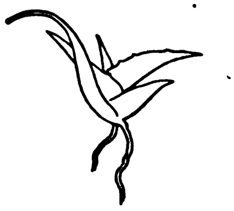


FIG. 16.—Agave seedling, natural size.

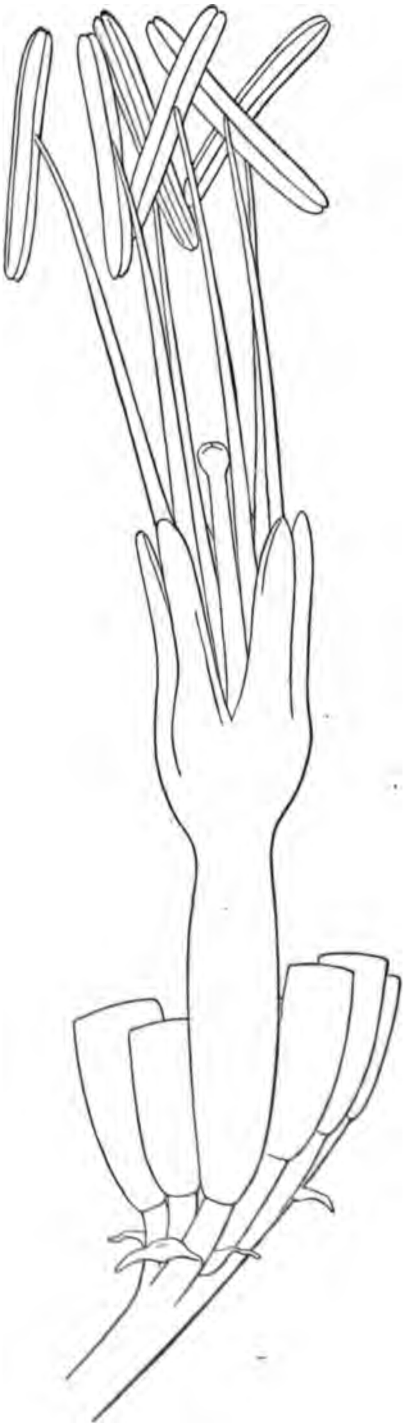


FIG. 15.—Flower of *Agave americana*, natural size.

Delphinoa Ross, Boll. R. Orto Bot. Palerm. **1**:117. 1897.

Type, *D. gracillima* Ross, l. c.

This is also *Agave potosina* Robinson & Greenman, Proc. Am. Acad. **29**:393. 1894.

The above genus was described as having the lower flowers in pairs while the upper ones are solitary.

SYNOPSIS OF THE NORTH AMERICAN SPECIES OF NISSOLIA.

The genus Nissolia was established by Jacquin in 1760 (Enum. Pl. Carib. 7).

In 1825 A. De Candolle (Prodr. **2**:257 to 259) monographed the genus, describing seventeen species. Of these, however, only three belonged to the genus Nissolia proper, viz, *N. fruticosa*, *N. hirsuta*, and *N. racemosa*, the latter two being there described for the first time.

In 1859 G. Bentham (in Mart. Fl. Bras. 15, pt. 1, pp. 76, 77) reduced these three to Jacquin's original *N. fruticosa*, and in addition described the species *N. platycarpa*.

Previously to Bentham, Dr. Gray (in 1852) and Dr. Torrey (in 1859) had each described a species under Chaetocalyx.

In 1861 (Journ. Linn. Soc. **5**:25, 26) Dr. Gray transferred these two species to Nissolia, recognizing four in all, viz, *N. fruticosa*, *N. platycarpa*, *N. wislizeni*, and *N. schottii*.

In the Biologia Centrali-Americana Mr. Hemsley lists five species, one being without specific name, and the specific name *hirsuta* being twice used on different authority. On the same page *N. schottii* and *N. wislizeni* are retained in Chaetocalyx.

Later, Watson described two additional species from Mexico, viz, *N. platycalyx* and *N. confertiflora*. All the above species except *N. racemosa* have been reported from Mexico. *N. hirsuta*, which was suppressed by both Bentham and Gray, appears to be distinct from *N. fruticosa*, to which they referred it. The type came from Guanajuato, Mexico, and I have recently had specimens from the type locality. *N. confertiflora*, it seems, should be referred to this species. *N. setosa* Brandegee[1] and *N. confertiflora laxior* Robinson are other names which have recently been published. The species are difficult to recognize, but the following key seems to separate them fairly well:

EXPLANATION OF FIGURES.

In all the following figures (Nos. 17 to 27) the same letter applies to the same part. Thus, fig. *a* is always the legume; fig. *b*, the flower; fig. *c*, the banner; fig. *d*, the wing; fig. *e*, the keel; fig. *f*, the stamens; fig. *g*, the ovary. The fruit is natural size; the flowers and flower parts are enlarged twice. Fig. 17, *N. wislizeni*, is made from a specimen collected by C. G. Pringle near Chihuahua in 1885 (No. 618). Fig. 18, *N. schottii*, is made from a specimen collected by C. G. Pringle near Altar, Sonora, in August, 1894. Fig. 19, *N. platycalyx*, is made from a duplicate type. Fig. 20, *N. pringlei*, is made from the type specimen. Fig. 21, *N. diversifolia*, is made from the type specimen. Fig. 22, *N. hirsuta*, is made from specimens collected by Mr. C. G. Pringle near Cuernavaca in 1886 (No. 6395). Fig. 23, *N. dodgei*, is made from specimens collected by Mr. Dodge near Monterey in 1891 (No. 131). Fig. 24, *N. multiflora*, is made from the type specimen. Fig. 25, *N. laxior*, is made from duplicate type. Fig. 26, *N. nelsoni*, is made from specimens collected by Mr. C. G. Pringle in the valley of Oaxaca in 1894 (No. 4640). Fig. 27, *N. fruticosa*, is taken from Hooker's Icones, vol. 6, No. 599.

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[1] Proc. Cal. Acad. ser. 2, **3**:127. 1891.

KEY TO NISSOLIA.

a. *Stems prostrate, creeping.*

Nissolia wislizeni Gray, Journ. Linn. Soc. **5**: 25. 1861. *Chaetocalyx wislizeni* Gray, Pl. Wright. **1**: 51. 1852. FIGURE 17.

This species has a wide distribution, extending from Arizona and New Mexico to Central Mexico. I collected it in the States of Durango and Zacatecas in 1897, from which, so far as I can learn, this is the first time it has been reported.

Specimens examined—

United States:

Arizona, Huachuca Mountains, September, 1882, *J. G. Lemmon* (No. 2668).
New Mexico, ———, *C. Wright*, 1851 (No. 1007).

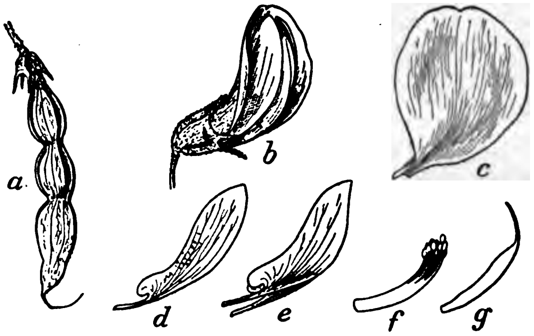

FIG. 17.—*Nissolia wislizeni.*

Mexico:

State of Chihuahua, hills and plains near Chihuahua, *C. G. Pringle*, June to August, 1885 (No. 618).
State of San Luis Potosi, chiefly in the region of San Luis Potosi, 22° north latitude, altitude 6,000 to 8,000 feet, *C. C. Parry* and *Edward Palmer*, 1878 (No. 133).
State of Durango, *J. N. Rose*, August 14 and 15, 1898 (Nos. 2278 to 2298).
State of Zacatecas, near Monte Escobedo, *J. N. Rose*, August 27, 1897 (No. 2651).

aa. *Stems climbing or twining.*

b. *Flowers all in small verticillate clusters.*

c. *Style terminal; legume with the apex of wing acute or acutish.*

d. *Calyx glabrous without, sometimes setose.*

Nissolia schottii (Torr.) Gray, Journ. Linn. Soc. **5**: 26. 1861. *Chaetocalyx schottii* Torr. Bot. Mex. Bound. 56, *t. 18.* 1859. FIGURE 18.

The type was collected by Schott at "Sierra Verde, Arroyo de los Samotas, Sonora."

This species seems to be confined to northwestern Mexico, extending into southern Arizona. Specimens so named from farther east are to be referred elsewhere. I have not been able to separate *Nissolia setosa* Brandegee,[1] the presence or absence of yellow setæ on the calyx being very variable.

Specimens examined—

United States:

Arizona, Santa Catalina Mountains, *C. G. Pringle*, August 3, 1881.

Mexico:

State of Sonora, by streams near Altar, *C. G. Pringle*, August 26, 1884; Guaymas, *Dr. Edward Palmer*, 1887 (No. 170); Alamos, *Dr. Edward Palmer*, September 16 to 30, 1890 (No. 638).

Lower California, San Pedro, *T. S. Brandegee*, October 30, 1890 (No. 140).

State of Chihuahua, southwestern part, *Dr. Edward Palmer*, August to November, 1885 (Nos. 57 and 113).

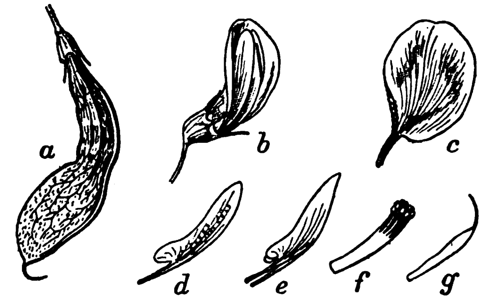

FIG. 18.—*Nissolia schottii.*

dd. *Calyx softly pubescent without.*

e. *Calyx broadly campanulate; banner cuneate at base.*

Nissolia platycalyx Wats. Proc. Am. Acad. **17**:344. 1882. FIGURE 19.

This species is known only from Dr. Edward Palmer's type specimens collected in the mountains east of Saltillo, 1880 (No. 248 in part). With this species was collected a second one, which was distributed under the same number. This will be found referred to below under the name of *N. dodgei*. We have a duplicate type (Type No. 293) in the National Herbarium.

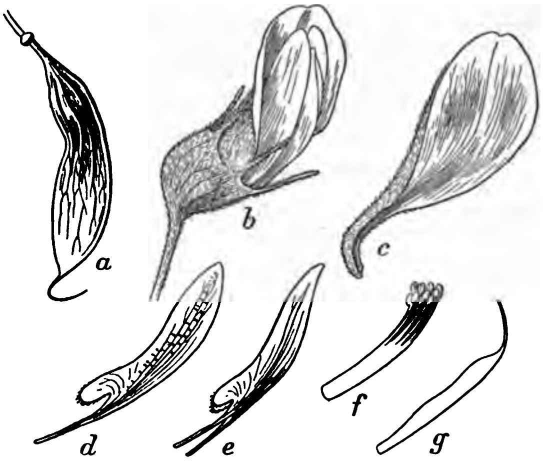

FIG. 19.—*Nissolia platycalyx.*

ee. *Calyx narrower, tubular; banner rounded at base.*

f. *Leaves dull green, lanceolate often acutish.*

Nissolia pringlei Rose, sp. nov. FIGURE 20.

Probably a climbing vine; leaflets 5, lanceolate to oblong, rounded at base, acute or obtuse at apex, long-apiculate, nearly or quite glabrous, pale green, rather thin in texture, 25 mm. or less long; calyx tubular, pubescent without, the tube a little over 2 mm. long, truncate between the filiform teeth; teeth shorter than the calyx tube; petals pubescent without; legume 2 or 3-jointed, pubescent, the upper or winged portion acute.

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[1] Proc. Cal. Acad. ser. 2, **3**: 127. 1891.

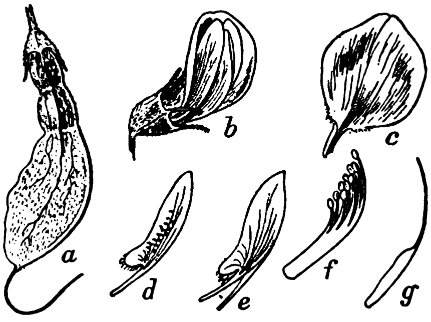

FIG. 20.—*Nissolia pringlei.*

Collected by Mr. C. G. Pringle in the Santa Eulalia Mountains, State of Chihuahua, September 15, 1885 (No. 324). This specimen was distributed as *N. schottii*, from which species it differs in its pubescent calyx, short calyx teeth, different foliage, etc.

The type is in the National Herbarium.

ff. *Leaves bright green, mostly orbicular, rounded or retuse at apex, thickened.*

Nissolia diversifolia Rose, sp. nov. FIGURE 21.

A twining shrub; leaflets 5, very variable in outline, usually shortly oblong, rounded or cordate, rarely cuneate, at base, rounded or retuse at apex, always apiculate, glabrous and shining above, nearly glabrous beneath, somewhat thickish in texture, 12 to 18 mm. long; calyx pubescent without, rarely setose, tubular, becoming somewhat campanulate in age, a little over 2 mm. long, truncate between the short (less than 2 mm. long) filiform teeth; corolla yellow tinged with red, the outer lobes pubescent; banner 8 mm. long, including the claw (2 mm. long), not auriculate at base, strongly retuse at apex; legume 2 mm. or more long, 2 or 3-jointed, the upper and winged portion acute.

Collected by Mr. C. G. Pringle about Tehuacan, State of Puebla, August and September, 1897 (No. 6693), and distributed under an untenable specific name.

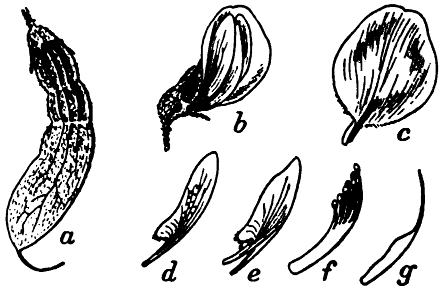

FIG. 21.—*Nissolia diversifolia.*

cc. *Style somewhat dorsal; legume with the wing obtuse or rounded at apex.*

g. *Flowers very small (calyx 1 mm. long; corolla 7 mm. long).*

Nissolia hirsuta DC. Prodr. **2**: 257. 1825. *Nissolia confertiflora* Wats. Proc. Am. Acad. **21**: 424. 1886. FIGURE 22.

Specimens examined—

Mexico:

State of Jalisco, near Colotlan, *J. N. Rose*, September 6, 1897 (No. 2813); Bolaños, *J. N. Rose*, September 9, 1897 (No. 2852); barranca, near Guadalajara, *C. G. Pringle*, July 25, 1893 (No. 5421); barranca of Tequila, *C. G. Pringle*, October, 1893 (No. 5421*b*); Tequila, *Dr. Edward Palmer*, August, September, 1886 (No. 338).

State of Zacatecas, San Juan Capistrano, *J. N. Rose*, August 20, 1897 (No. 3541).

State of Durango, *J. N. Rose*, August 15, 1897 (No. 2301).

State of Morelos, near Cuernavaca, altitude 5,000 feet, *C. G. Pringle*, July 24. September 15, 1896 (No. 6395).

State of Sinaloa, Culiacan, *Dr. Edward Palmer*, August 27 to September 15, 1891 (No. 1496).

State of Oaxaca, Tomellin Cañon, altitude 3,500 feet, *C. G. Pringle*, July 17, 1897 (No. 7467).
State of Guanajuato, *Prof. A. Dugès*, 1891.
State of Chihuahua, San Jose, southwestern part of State, *Dr. Edward Palmer*, August to November, 1885 (No. 42).

gg. *Flowers larger (calyx 2 mm. or more long; corolla much larger than in the last).*

h. *Calyx and pod setose; pod also very pubescent.*

Nissolia dodgei Rose, sp. nov. FIGURE 23.

Stems climbing, finely canescent; leaflets elliptical, oblong, or nearly orbicular, somewhat apiculate, pubescent on both surfaces, 1 to 2 cm. long; flowers numerous on slender pedicels, yellowish, 5 to 10 mm. long; calyx sparsely setose, its teeth filiform, more than half the length of the tube; legume somewhat falcate, 2 cm. long, strongly pubescent, 2 or 3 seeded, the basal portion bearing scattered yellow setæ, the broad expanded wing obtuse at apex.

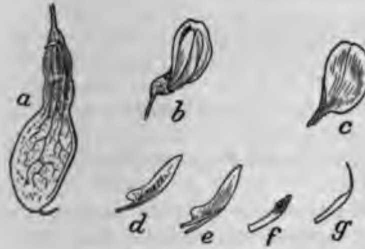

FIG. 22.—*Nissolia hirsuta.*

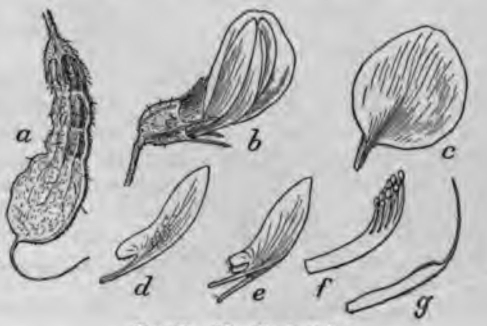

FIG. 23.—*Nissolia dodgei.*

Specimens examined—

Mexico:

State of Coahuila, mountains east of Saltillo, *Dr. Edward Palmer*, 1880 (No. 248, in part); near Monterey, *Charles K. Dodge*, May, 1891 (No. 131).

hh. *Calyx and pods not setose.*

i. *Leaflets small; sepals mostly shorter than the tube.*

Nissolia multiflora Rose, sp. nov. FIGURE 24.

Stems climbing, pubescent, leaflets 5, orbicular or shortly oblong, rounded or slightly cordate at base, rounded at apex and with a slender apiculation, 10 to 18 mm. long, somewhat pubescent; flowers numerous in the axils of the leaves, yellow or purplish; calyx nearly glabrous, 3 mm. long, not setose, truncate between the lobes; calyx teeth filiform nearly equal to the length of the calyx tube; outer petals pubescent and ciliate on the margins, rose-colored; ovary pubescent, 2 or 3 ovuled; legume 2.5 mm. long including the broad obtuse wing.

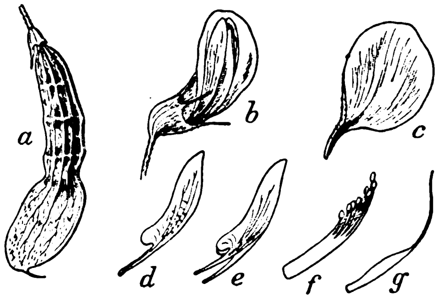

FIG. 24.—*Nissolia multiflora.*

Collected by C. G. Pringle (No. 6064) on Mount Alban, near Oaxaca, altitude 5,800 feet, November 23, 1894.

ii. *Leaflets large; sepals longer than the tube.*

Nissolia laxior (Robinson) Rose; *Nissolia confertiflora laxior* Robinson, Proc. Am. Acad. **29**:315. 1894. FIGURE 25.

Apparently a good species. It is only known from the type collection and the fruit is still unknown.

Collected by Mr. C. G. Pringle in a barranca near Beltram, State of Jalisco, June 5, 1893 (No. 4379).

bb. *Flowers usually (or always) in naked racemes; calyx teeth very small.*

k. *Calyx truncate with small linear teeth.*

Nissolia guatemalensis Rose, sp. nov.

Probably a shrubby vine; the younger parts somewhat pubescent; leaflets lanceolate, rounded at base, slightly tapering but obtuse at apex, mucronate, glabrous above (at least in age), puberulent beneath; flowers in racemes; calyx small, 2 to 2.5 mm. long, truncate with small linear teeth much shorter than the tube, becoming nearly glabrous; pods on slender stipes twice as long as the calyx, 35 mm. long, the terminal wing acute.

Collected in Guatemala by Sutton Hayes, near Esquintla, November, 1860 (specimen in Herb. Gray), and by Heyde & Lux, near Cuajiniquilapa, in 1893, and distributed by John Donnell Smith as No. 6112.

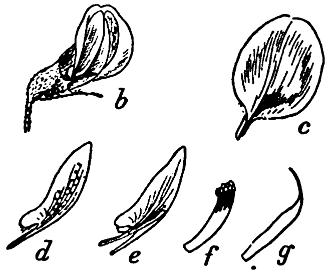

FIG. 25.—*Nissolia laxior.*

kk. *Calyx not truncate; teeth triangular.*

l. *The terminal wing of fruit obtuse. Mexican species.*

Nissolia nelsoni Rose, sp. nov. FIGURE 26.

Shrubby vine climbing 36 to 45 dm. high, glabrous or younger parts pubescent; leaves large; leaflets 5, nearly glabrous in age, oval to obovate, rounded or acute at apex, broadly cuneate or rounded at base, 2.5 to 7.5 cm. long, 16 to 36 mm. broad; flowers in terminal or axillary racemes, 15 to 25 cm. long in fruit; calyx cup-shaped, 1 mm. long, puberulent, the minute teeth triangular; corolla 6 mm. long, pale yellow; banner orbicular, horizontal, retuse; ovary pubescent; fruit 2 or 3 jointed, the upper joint broadly winged, obtuse, 18 to 25 mm. long, 8 to 10 cm. broad.

Collected by Mr. E. W. Nelson from the Valley of Oaxaca, September 20, 1894 (No. 1266); by Mr. C. G. Pringle, May 19 and August 17, 1894 (No. 4640); and by Mr. E. W. Nelson near Tuxtla, State of Chiapas, September 1 to 8, 1895 (No. 3086). It is probably, also, Bourgeau's No. 1477, collected in the valley of Cordova.

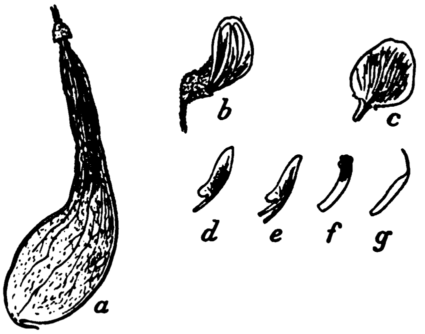

FIG. 26.—*Nissolia nelsoni.*

Flowering specimens collected by Rev. Lucius C. Smith at Colderon, San Juan del Estado, June, 1894, and by Mr. Henry E. Seaton near Cordoba, August, 1891, have somewhat different leaves and suggest *N. fruticosa*. Better material may show that they belong elsewhere.

This species differs from *N. fruticosa* in the shape of the leaflets, and in the calyx and fruit.

11. *Terminal wing of fruit acute; South American species.*

Nissolia fruticosa Jacq. Enum. Pl. Carib. 27. 1760. *Nissolia racemosa* DC. Prodr. **2**:257. 1825. (Fide Benth.) FIGURE 27.

I have seen no authentically named specimens of this species, but if the illustration in Hooker's Icones (which in part is here reproduced) and the one in Flora Brasiliensis are correct all our Mexican material is to be excluded. *N. hirsutiflora* DC., usually referred as a synonym of this species, is to be restored to specific rank. Fruiting specimens collected by Fendler in Venezuela in 1854 and 1855 (No. 194) and now in Herb. Gray answer this species better than anything else which I have seen.

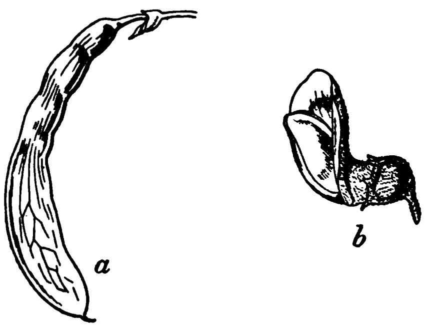

FIG. 27.—*Nissolia fruticosa.*

UNCERTAIN SPECIES.

Nissolia platycarpa Benth. in Mart. Fl. Bras. **15**, pt. 1:77. 1859.

I have not been able to place this Mexican species, owing to the very meager description. Dr. Gray thought it was the same as *N. wislizeni*, and in the Biologia it is stated to be the same as *N. schottii*. Mr. Hemsley suggests that it is the same as Palmer's No. 248, in part, for which I have proposed the name *N. dodgei.*

The type of the species is Coulter's plant from Zimapan, State of Hidalgo, and hence widely separated from Palmer's locality in Coahuila. *N. platycarpa* is decribed as having the fruit one-nerved, and in this respect differs from all the species which I have seen.

Nissolia (?) sp.

Palmer's No. 7, from Acapulco, has much the appearance of this genus, although the specimens do not conform to any of the above descriptions.

NOTES ON RUTACEAE.

To the notes on this order published earlier in this volume[1] the following are to be added:

ZANTHOXYLUM.

Zanthoxylum insulare[2] Rose, North Am. Fauna, No. **14**:79. 1899.

Tree 6 to 20 meters high, thornless; leaves oddly pinnate; leaflets 6 or 7 pairs, opposite, sessile, obovate to spatulate, obtuse or retuse, 2 to 3.5 cm. long, crenate, with large pellucid dots between the teeth and small scattered dots over the surface, glabrous; flowers unknown; fruit small, in a rather compact panicle; pedicels very short; stipe short or thick.

Collected by E. W. Nelson on Maria Madre Island. May 3 to 25, 1897 (No. 4278).

Zanthoxylum longipes Rose, sp. nov.

Probably a tree; branches with a few small, scattered, hooked spines; young branches green, somewhat angular, glabrous or slightly puberulent (likewise the leaflets); leaves small on short petioles; leaflets always 3, quite variable in outline, some orbicular to oblong, others obovate to lanceolate, 1 to 3 cm. long, shining above, with many pellucid dots, the margin undulate, sessile or subsessile, rounded and retuse at apex, cuneate or rounded at base and bearing on each side a glandular callosity; inflorescence compact, the cluster 1 to 3 cm. long; cocci 1 or 2, 3 mm. in diameter, borne on a slender stipe 2 mm. long; seed glabrous.

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[1] No. 3, pp. 110 to 113.

[2] The original description is here reproduced.

Collected by Mr. C. G. Pringle on limestone hills near Tehuacan, altitude 5,000 feet, August 28, 1897 (No. 6691).

Zanthoxylum nelsoni Rose, North Am. Fauna, No. **14**: 79. 1899.

Tree 7.5 to 20 meters high, thornless (?); leaves oddly pinnate; leaflets about 6 pairs, distant, opposite, shortly petioled, 5 to 11 cm. (2 to 4½ inches) long, rounded at base, long-acuminate, crenate, glabrous on both sides, thickly set with pellucid dots; inflorescence in small compact panicles; perianth complete; petals 4 (?); fruit large, in dense headlike clusters, not stipitate.

A very peculiar species, unlike any Mexican one known to me. Collected by E. W. Nelson on the Maria Madre Island, May 3 to 25, 1897 (No. 4279).

Zanthoxylum occidentale Rose, sp. nov.

A large tree 7.5 meters high, with large rounded top; branches with short straight thorns, glabrous throughout; leaves 10 to 15 cm. long; leaflets 5 to 9, petiolulate, cuneate at base, obtusely acuminate, 3 to 5 cm. long, glabrous on both sides, the surface sprinkled with small pellucid dots, the margin undulate or crenate, the teeth separated by large pellucid dots; inflorescence a short dense panicle.

Apparently a common tree along the coast; seen both at Acaponeta and Rosario.

Collected by J. N. Rose near Acaponeta, July 2 and 3, 1897 (No. 1519), and at Rosario, July 22 (No. 1820).

Zanthoxylum pterota (L.) H. B. K. Nov. Gen. et Sp. **6**: 3. 1826. *Fagara pterota* L. Syst. ed. 10, 897. 1759.

A large bushy shrub, 30 dm. high, with long, drooping branches.

Collected by J. N. Rose at Acaponeta, June 23, 1897 (No. 1442), and near Rosario, July 10 (No. 1586).

The following artificial key will serve to hold these Mexican and Central American species together until those that are little known have been re-collected and studied.

KEY TO THE SPECIES OF ZANTHOXYLUM.

a. *Leaves simple.*

b. *Plants thorny.*

Z. pentanome DC. Prodr. **1**: 725. 1824.

bb. *Plants thornless.*

Z. ghisbreghtii Turcz. Bull. Soc. Nat. Mosc. **32**, 1: 274. 1859.

aa. *Leaves pinnate.*

c. *Rachis winged.*

Z. pterota (L.) H. B. K. Nov. Gen. et Sp. **6**: 3. 1823. *Fagara pterota* L. Syst. ed. 10, 897. 1759.

cc. *Rachis not winged.*

d. *Leaflets 1 to 3 pairs (rarely 4 pairs).*

Z. limoncello Planch. & Oerst; Triana & Planch. Ann. Sci. Nat. ser. 5, **14**: 312. 1872.
Z. melanostictum Schlecht. & Cham. Linnæa, **5**: 231. 1830.
Z. arborescens Rose, Contr. Nat. Herb. **5**: 112. 1897.
Z. longipes Rose, supra.
Z. foetidum Rose, Contr. Nat. Herb. **5**: 112. 1897.
Z. occidentale Rose, supra.

dd. *Leaflets many pairs, always more than 3.*

Z. affine H. B. K. Nov. Gen. et Sp. **6**: 3. 1823.
Z. rigidum H. B. K.; Willd. Sp. Pl. **4**: 756. 1805.
Z. nelsoni Rose, North Am. Fauna, No. **14**: 79. 1899.
Z. insulare Rose, loc. cit.
Z. foliolosum Donnell Smith, Bot. Gaz. **18**: 1. 1893.
Z. pringlei Wats. Proc. Am. Acad. **26**: 134. 1891.

MISCELLANEOUS SPECIES.

Casimiroa edulis Llav. & Lex. Nov. Veg. Desc. fasc. **2**: 2. 1825.

Collected by J. N. Rose at Mazatlan, June 17 to 19, 1897 (No. 3105); at Acaponeta, July 1 to 3, 1897 (No. 3119), and near Colotlan, August 28 (No. 2678). My specimens differ somewhat from our only two herbarium specimens in having normally 5 leaflets instead of 3, and these duller, more pubescent, and more tapering at apex.

The inflorescence of this genus is described by Bentham and Hooker as a few-flowered axillary panicle. My specimens show both axillary and terminal, many-flowered panicles, 5 to 10 cm. long.

This plant produces the zapote blanco of the Mexicans.

Citrus medica L. Sp. Pl. **2**: 782. 1753.

A small tree in the foothills, growing as an escape.

Collected by J. N. Rose near Colomas, July 18, 1897 (No. 1740).

Ptelea trifoliata mollis Torr. & Gr. Fl. **1**: 680. 1840.

Leaflets large. Common on the table-land.

Collected by J. N. Rose on the road between Huejuquilla and Mesquitec, August 25, 1897 (No. 2580).

NOTES ON TURNERACEAE.

Three genera of this order are found in Mexico, viz, Piriqueta, Esblichia, and Turnera. *Piriqueta cistoides*, the only known Mexican species of the genus, has not been collected in Mexico in recent years. Relating to the other two genera I have the following matter:

ESBLICHIA.

Esblichia odorata Seem. Bot. Herald, 130. 1857.

Collected by Mr. E. W. Nelson near Chicharras, in the State of Chiapas, February 12 to 15, 1896 (No. 3803).

A tree 40 to 50 feet high.

This plant has not before been reported from Mexico, having been known only from Panama and there but once collected.

This species is figured in Botany of the Herald as t. 27. Mr. Urban refers this genus to a section Piriqueta, from which, however, it appears to be quite distinct.

TURNERA.

The following species, sent for identification or otherwise contributed, have been recently added to the National Herbarium:

Turnera palmeri Wats. Proc. Am. Acad. **22**: 413. 1886.

Collected by J. N. Rose near Huejuquilla, Jalisco, August 24, 1897 (No. 3562).

This plant was frequently seen on the table-lands. It has heretofore been reported only from near Guadalajara, Jalisco, the type having been collected by Dr. E. Palmer in 1885 and since obtained by Mr. Pringle and P. L. Jouy. In the original description the leaves are said to be eglandular, but this is a mistake.

This species must be near *T. callosa.*

Turnera pringlei Rose, sp. nov.

Low, bushy shrub, 15 to 50 cm. high; young branches, leaves, calyx, etc., densely and softly silky pubescent; leaves oblong to obovate, 12 to 40 mm. long, obtuse, tapering at base into a short petiole, serrate, more or less rugose; flowers solitary in the axils, sessile; bracts 2, linear, pubescent, 4 mm. long, not glandular; calyx 6 mm. long, the lobes twice as long as the tube, ovate, acuminate, pubescent without; petals yellow, obovate, 6 mm. long; filaments free to the base, glabrous; styles 2, glabrous; capsule 3 mm. long, somewhat hairy; seeds obovate, twice as long as broad, less than 2 mm. long.

Collected by Mr. C. G. Pringle near Tehuacan, in eastern Puebla, 1897 (No. 6692). Perhaps here may be referred specimens collected by Mr. E. W. Nelson near San Geronimo and La Venta, State of Oaxaca, altitude 200 feet, July 13, 1895 (No. 2780), and by J. N. Rose near San Juan Capistrano, August 18, 1897 (No. 3536).

Turnera ulmifolia L. Sp. Pl. **1**: 271. 1753.

Collected by Mr. C. G. Pringle on sand dunes, Tampico, State of Tamaulipas, 1898 (No. 6821).

Turnera ulmifolia alba (Liebm.) Rose. *Turnera alba* Liebm. Ann. Sci. Nat. ser. 3, **9**: 318. 1848. *Turnera ulmifolia velutina* subvar. 2, Urb. Jahrb. des Kgl. Bot. Gart. Mus. Berl. **2**: 141. 1883.

Stems 3 to 6 dm. high. Collected by Mr. C. G. Pringle in Tomellin Canyon, State of Oaxaca, 1897 (No. 6719); by Mr. E. W. Nelson between Niltepec and Zacatepec, State of Oaxaca, altitude 400 feet, July 15, 1895 (Nos. 2816, 2807); also vicinity of Cuicatlan, State of Oaxaca, altitude 1,800 to 2,500 feet, October 8 to 16, 1894 (No. 1659), and vicinity of San Juan Guichicovi, State of Oaxaca, altitude 450 to 1,500 feet, June 21 to 24, 1895 (No. 2714).

I have followed Mr. Urban in keeping this white-flowered Turnera under the species *ulmifolia*. It does not belong, however, with his variety *velutina*. The latter is certainly a good species, and I have so considered it in my treatment below.

The type locality is stated to be "ad ripas Rio de las Vueltas," which is probably near Mr. Pringle's locality.

Turnera ulmifolia surinamensis Urb. Jahrb. des Kgl. Bot. Gart. Mus. Berl. **2**: 143. 1883.

Collected by Mr. E. W. Nelson in Santa Efigenia, State of Oaxaca, Mexico, altitude 500 feet, July 18, 1895 (No. 2849a); also between Niltepec and Zacatepec, State of Oaxaca, Mexico, altitude 400 feet, July 15, 1895 (No. 2816).

It is questionable whether our Mexican form should not be separated specifically from *T. ulmifolia*.

Turnera ulmifolia caerulea (DC.) Urb. Jahrb. des Kgl. Bot. Gart. Mus. Berl. **2**: 144. 1883. *Turnera caerulea* DC. Prodr. **3**: 346. 1828.

Collected by J. N. Rose near Colomas, July 16, 1897 (No. 1692), and between Aguacota and Dolores, Tepic, August 6, 1897 (No. 3357).

Turnera humifusa (Presl) Endl. in Walp. Rep. **2**: 230. 1843. *Bohadschia humifusa* Presl, Reliq. Haenk. **2**: 98. 1830. *T. aphrodisiaca* Ward, Virg. Med. Month. April, 1876: 49. 1876. *T. diffusa aphrodisiaca* Urb. Jahrb. des Kgl. Bot. Gart. Mus. Berl. **2**: 127. 1883.

Collected by Dr. E. Palmer, near Acapulco, October, 1894, to March, 1895 (No. 133), and J. N. Rose, between Rosario and Colomas, Sinaloa, July 12, 1897 (No. 1612).

This must be the *Bohadschia humifusa* of Presl, which was originally collected at Acapulco. Dr. Palmer's plant agrees exactly with the description, except that the flowers are said to be rose-colored.

I am inclined to think that this Mexican form, which Dr. Urban considered as a variety of *T. diffusa*, deserves specific rank. It differs from the West Indies specimens in its pubescence and in its larger, thinner, and more glabrous leaves. Before the question can be definitely settled more material should be collected in the West Indies showing the variations of the typical form. The name *humifusa* is much older than any other, and in case the species should be reduced to varietal rank that name should be used in preference to *aphrodisiaca*.

An exhaustive monograph of this genus was published by Dr. I. Urban in 1883.[1] Fifty-four species are enumerated. The genus Turnera is strictly an American one, Brazil being the center of distribution; forty of the species are found in that country. Urban refers three species to Mexico, only one (*T. callosa*) being endemic; two to Central America, one (*T. panamensis*) being endemic; or four species to the two countries.

Three years before this Mr. Hemsley, in the Biologia Centrali-Americana, enumerated fourteen species for these countries, three being given without specific names. The names there used were so widely at variance with Urban's monograph, that Mr. Hemsley published a rearrangement of the species in the supplement to the Biologia Centrali-Americana. For the benefit of those who may be working in this group, I have thought best to publish these lists in parallel columns along with a third, which shows my own treatment of the genus.

Three treatments of the species of Turnera.

Species listed by Hemsley.	Species recognized by Urban.	Species and varieties now recognized.
1. *T. alba* Liebm.	1. *T. ulmifolia velutina* (Presl) Urb. subvariety 2.	1. *T. ulmifolia alba* Rose.
2. *T. aphrodisiaca* L. F. Ward.	2. *T. diffusa aphrodisiaca* (Ward) Urb.	2. *T. humifusa* (Presl) Endl.
3. *T. caerulea* DC.	3. *T. ulmifolia cacrulea* (DC.) Urb.	3. *T. ulmifolia caerulea* (DC.) Urb.
4. *T. cistoides* L.	4. *Piriqueta cistoides* Griseb.	4. Not of this genus.
5. *T. hindsiana* Benth.	5. *T. panamensis* Urb.	5. Not Mexican.
6. *T. humifusa* (Presl) Endl.	6. *T. diffusa* Willd.	6. *T. humifusa* (Presl) Endl.
7. *T. mollis* H. B. K.	7. *T. ulmifolia elegans* (H. B. K.) Urb. subvariety 2.	7. Not Mexican.
8. *T. pumilea* L.	8. Not credited to Mexico.	8. *T. pumilea*.
9. *T. trioniflora* Sims.	9. *T. ulmifolia elegans* (H. B. K.) Urb.	9. *T. ulmifolia elegans* Urb.
10. *T. ulmifolia* L.	10. *T. ulmifolia* L.	10. *T. ulmifolia* L. *T. ulmifolia acuta* Urb. *T. ulmifolia surinamensis* (Miq.) Urb.
11. *T. velutina* Presl.	11. *T. ulmifolia velutina* (Presl) Urb.	11. *T. velutina* Presl.
12. *Turnera* sp.	12.	12. Not Mexican.
13. *Turnera* sp.	13. *T. panamensis* Urb.	13. Not Mexican.
14. *Turnera* sp.	14.	14.
	15. *T. callosa* Urb.	15. *T. callosa* Urb.
		16. *T. palmeri* Watson.
		17. *T. pringlei* Rose.

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[1] Jahrbuch des Kgl. Bot. Gart. und Mus. Berlin, **2**: 1 to 152.

KEY TO THE MEXICAN SPECIES OF TURNERA.

a. *Leaves biglandular at base.*

b. *Stems herbaceous, rather low, sometimes cespitose; glands borne on the blade; seeds few (25 or less).*

T. palmeri Watson.
T. callosa Urb.

bb. *Stems somewhat woody; glands borne on the petiole; seeds 50 or more.*

c. *Leaves densely clothed with a yellow, velvety pubescence, and very prominently veined.*

T. velutina Presl.

cc. *Leaves not velvety-pubescent, thin, not strongly veined.*

d. *Flowers blue.*

e. *Leaves linear.*

T. ulmifolia surinamensis (Miq.) Urb.

e. *Leaves broader (not linear).*

T. ulmifolia caerulea (DC.) Urb.

dd. *Flowers yellow or white.*

T. ulmifolia L.
T. ulmifolia acuta Urb.
T. ulmifolia alba Rose.

aa. *Leaves not biglandular at base.*

e. *Annuals; seeds tuberculate.*

T. pumilea L.

ee. *Perennials; seeds reticulated.*

T. humifusa (Presl) Endl.
T. pringlei Rose.

NOTES ON THE MEXICAN SPECIES OF CLITORIA.

The genus was monographed by Bentham in the Journal of the Linnæan Society, 1858, pp. 33–44.

I have here brought together the Mexican and Central American species practically in the order treated by Bentham, adding in their proper place the species which have since been discovered. I am strongly inclined to think, although Mr. Bentham reached a different conclusion, that *C. mexicana* is quite distinct from *C. mariana*; but the subject really requires further investigation. I have never seen *mariana* from Mexico, but there are specimens in the National Herbarium from southern Arizona, and it will naturally be looked for across the border. *C. mexicana* is restricted to south Mexico and Central America.

KEY TO THE SPECIES.

a. *Leaflets more than 3; bractlets broad.*

Clitoria ternatea L. Sp. Pl. **2**: 753. 1753.

This beautiful little vine was found in cultivation at Rosario, Sinaloa, July 11, 1897, by J. N. Rose (No. 1598).

aa. *Leaflets 1 to 3; bractlets linear.*

b. *Stems climbing.*

Clitoria (?) multiflora Mart. & Gall. Bull. Acad. Brux. **10**, pt. 2: 188. 1843.

This species is based on specimens collected by Galeotti at "Mirador," State of Vera Cruz, and near "Comaltepeque."

I do not know this species. I have seen a specimen of Clitoria from Mirador, but it does not agree with the description of the above.

Clitoria glycinoides DC. Prodr. **2**: 234. 1825.

This species is reported from Panama. I have seen specimens only from Jamaica.

Clitoria mexicana Link, Enum. **2**: 235. 1822.

Stems climbing, more or less pilose; leaflets 3, ovate to lanceolate, acute to shortly acuminate, rounded at base, glabrous above, pale and slightly pilose beneath, 2.5 to 5 cm. long; petioles 10 to 35 mm. long; stipules and bractlets similar, but the latter narrower; peduncles short, 2 or 3 flowered; calyx tube purplish, 10 mm. long; the teeth ovate, acute; flowers purplish (?); pods stipitate, flattened, 4 to 5 cm. long, constricted between the seeds.

Collected by Mr. E. W. Nelson, near Totontepec, July 21 to 27, 1894, and by Mr. C. G. Pringle, near Las Sedas, September 24, 1894 (No. 5846), both places in the State of Oaxaca; by E. W. D. Holway, near Jalapa, State of Vera Cruz, October 3, 1898 (No. 3088); by Dr. C. Sartorius, Mirador, State of Vera Cruz; by Heyde & Lux, in Guatemala, November, 1892 (No. 4144).

This is apparently the *C. mexicana* of Link, which Mr. Bentham has referred to *C. mariana*, from which, however, it seems clearly distinct. *C. mariana* has the stipules narrower, the leaves broader, obtuse, with the under surface perhaps not so pale, the pods more shiny and less constricted between the seeds, the calyx not purplish, and the flowers considerably larger.

Clitoria javitensis (H. B. K.) Benth. Journ. Linn. Soc. **2**: 42. 1858. *Neurocarpum javitense* H. B. K. Nov. Gen. et Sp. **6**: 409. 1823.

I have seen no Mexican specimens. The type comes from South America.

aa. *Stems erect.*

Clitoria polystachya Benth. Pl. Hartw. 60. 1840.

The type of this species was collected by T. Hartweg at Talea, State of Oaxaca.

I have referred here Mr. Nelson's No. 849 from near Choapam, State of Oaxaca, July 28, 29, 1894.

Clitoria triflora Wats. Proc. Am. Acad. **22**: 407. 1887.

Collected by J. N. Rose on the west side of the east range of the Sierra Madre in the State of Durango, August 16, 1897 (No. 3519.)

This species has heretofore been found only in the State of Jalisco.

Clitoria humilis Rose, sp. nov.

Stems low, erect, 10 to 12 cm. high, puberulent; leaflets 3, oblong, 3 to 6 cm. long, rounded at base, rounded or retuse at apex, glabrous above, pale, reticulated, and becoming glabrate beneath; peduncle nearly wanting, 2-flowered; bractlets narrow, acute; calyx 10 mm. long, not purplish; the two upper teeth united to near the middle, all acute; banner 36 mm. long, yellowish.

Collected by J. N. Rose on the east side of the west range of the Sierra Madre, in the State of Durango, August 13, 1897 (No. 2251).

Clitoria subsessilis Rose, sp. nov.

Stems herbaceous, erect, 1 to 2 dm. high, somewhat pilose; leaflets 1 or 3, oblong, rounded at apex, sometimes retuse, mucronate, rounded at base, glabrous above, paler and at first somewhat pilose, but becoming glabrate beneath, distinctly reticulate, especially above, 5 to 10 cm. long, 2 cm. or less wide; petioles very short or wanting; stipules ovate, acute, nerved; peduncles short, 2-flowered; the subtending bractlets of the shape and size of the stipules; calyx 16 to 18 mm. long, pilose; sepals 5, the 2 upper ones united to the middle, all acuminate; banner 4 cm. long, glabrous, purplish. Pods not seen.

Collected by Mr. E. W. Nelson in the State of Oaxaca between Guichocovi and Lagunas, June 27, 1895 (No. 2748), and near Santa Efigenia, July 18, 1895 (No. 2845).

SPECIES DOUBTFUL OR TO BE EXCLUDED FROM CLITORIA, OR FROM THE MEXICAN FLORA.

Clitoria (?) **sericea** Wats. Proc. Am. Acad. **22**:407, 1887; **29**:315, 1894, is not of this genus, but may be a Cracca (Tephrosia).

Clitoria mariana L. Sp. Pl. **2**:753. 1753.

The only species found in the United States, where it is common. It has been reported from Mexico, but the determinations thus far have proved incorrect.

Clitoria grandiflora Mart. et Gal. Bull. Acad. Brux. **10**, pt. 2:189. 1843.

The type of this species was collected by Galeotti at Mirador and Zacuapan. It is probably to be referred to Centrosema.

Clitoria schiedeana Schlecht. Linnæa, **12**:284. 1838.

This species was based on specimens collected at Jalapa and Hacienda de la Laguna. It is described as having a broad, campanulate calyx with 4 teeth. It suggests a Centrosema.

Clitoria speciosa Cav. Desc. 182. 1802.

I do not know this species.

Clitoria portobellensis Beurling, Vetensk. Akad. Handl. Stockh. **1854**:119. 1856.

Unknown to me.

NOTES ON MALVACEAE AND BOMBACEAE.

ABUTILON.

Abutilon crispum Medic. Malven-fam. 29. 1787.

Common under bushes, etc. Collected by J. N. Rose at Altata, Sinaloa, June 15, 1897 (No. 1336), and at Guaymas, June 5 to 11 (No. 1236).

Abutilon goldmani Baker, f. & Rose, sp. nov.

Shrub 18 to 30 dm. high; young branches covered with reddish stellate hairs; petioles 10 to 15 cm. long; blade nearly orbicular, acuminate, cordate at base, 12 to 18 cm. broad; 7-nerved at base, pale and densely stellate beneath, green and somewhat stellate, becoming glabrate above; peduncles 5 to 10 cm. long; calyx 2½ cm. high, deeply lobed, covered with a dense mass of reddish stellate hairs; sepals obtuse, strongly 3-ribbed on the back; petals large, 5 cm. long, yellow; stamen tube slender and long (2½ cm.), glabrous; capsule 2 cm. high, flat-topped, glabrate except for some tufts of stellate hairs at the top and on the angles; carpels numerous, each crowned with a very prominent crest.

Collected by E. A. Goldman, Papantla, State of Vera Cruz, March 14, 1898 (No. 86). Mr. E. G. Baker says of this species, "Allied to *A. sylvaticum* Schumann, but quite distinct."

Abutilon incanum (Link) Sweet, Hort. Brit. 53. 1827. *Sida incana* Link, Enum. Hort. Berol. **2**:204. 1822.

A very common plant. Collected by J. N. Rose at Guaymas, June 8, 1897 (No. 1254), and at San Juan Capistrano, August 20 (No. 2449).

Abutilon jaquini Don, Hist. Dichl. Pl. **1**:503. 1831.

Collected by J. N. Rose, at San Juan Capistrano, August 19, 1897 (No. 2425), and at Bolaños, September 10 (No. 2886).

The type of this species comes from Jamaica, but I have as yet seen no specimens from outside of Mexico.

Abutilon reticulatum Rose, sp. nov.

A shrub 3 to 4.5 meters high; young branches densely white-velvety; leaves very variable, often very large; petioles often 15 cm. long, the blade nearly orbicular, sometimes 15 to 25 cm. in diameter, acuminate, occasionally faintly 3-lobed, with a deep sinus at base, denticulate, densely velvety on both sides, greener and becoming nearly glabrous above, white and permanently pubescent beneath, there also somewhat prominently reticulated; stipules large, ovate, acute, somewhat cordate at base, deciduous; inflorescence somewhat variable, terminating stem or branches, sometimes appearing as a simple raceme, at other times as a long open panicle, 6 dm. long; calyx deeply 5-parted; lobes broadly ovate, acute, 5 to 6 mm. long, villous on both sides; petals yellow, 12 mm. long; base of stamen tube swollen, densely stellate; carpels 9, long-pilose, acute at tip, 3-seeded.

Collected by Mr. C. G. Pringle (No. 6062) in the State of Oaxaca; by Rev. Lucius C. Smith (No. 322) on Monte Alban, near the city of Oaxaca, altitude 5,800 feet, November 23 and 24, 1894; and by Mr. E. W. Nelson between Copala and Juchitango, altitude 200 to 600 feet, February 9, 1895 (No. 2296). The species has been in cultivation for several years in the botanical greenhouses at Washington (J. N. Rose, No. 1122).

This species has been distributed in Mr. Pringle's sets as *A. reventum*, with which it is closely allied, but from which it differs in having more reticulate leaves, different calyx, etc. This may be the little-known *A. andreuxii*, but the latter is described as an herb, the inflorescence as a broad cymose panicle, etc.

Mr. E. G. Baker points out that this species is allied to *A. elatum* Griseb., but has different pubescence on the carpels. The most striking difference is in the velvety branches (not at all pilose) and in the large more or less imbricating stipules, which almost hide the stem in its upper parts.

Mr. Greenman has also more lately compared my species with *A. elatum*, and under date of October 28, 1898, writes as follows:

"I have compared your Abutilon with *A. elatum* Griseb., and it is *not* the same. Grisebach's species is represented here by a specimen collected in Jamaica by Wilson and labeled in Grisebach's handwriting. In *A. elatum* the stem and petioles are velvety-tomentose, but the pubescence is decidedly longer and of a more villous nature than in your plant. Moreover, in *A. elatum* the nerves on the under surface of the leaves are covered with short stellate hairs, but having long spreading villous hairs intermixed."

Abutilon reventum Wats. Proc. Am. Acad. **21**: 418. 1886.

Collected by J. N. Rose at San Juan Capistrano, August 22, 1897 (No. 2463), and at Bolaños, September 10 to 19 (No. 2905).

This species, based upon Dr. Palmer's South Chihuahuan species, has since been found only along our southern border. It may be expected in the tropical valleys north from the State of Jalisco.

Abutilon venosum Walp. Ann. **2**: 158. 1851.

A shrub.

Collected by E. A. Goldman at Huanchinango, State of Puebla, altitude 5,000 feet, January 8, 1898 (No. 14).

This species had not been reported from Mexico. It corresponds exactly with specimens from Central America.

Abutilon sp.

Leaves and fruit of an Abutilon were collected by J. N. Rose at Mazatlan in June, 1897, which Mr. Baker says is near *A. permollis* Sweet. This species, however, has not heretofore been reported from Mexico.

ANODA.

Anoda caudatifolia Robinson & Greenman, in lit. *Sida caudatifolia* Robinson & Greenman, Proc. Am. Acad. **29**: 382. 1894.

This species proves to be a good Anoda near *A. pentaschista* and *A. abutiloides.*

Anoda crenatiflora Ortega, Nov. aut. Rar. Pl. Dec. **8**:96. 1798. *Anoda parvifolia* Cav. Icones, **5** : 19, *t. 431.* 1799.

It seems best to consider, as has usually been done, that these two names probably apply to the same species. Cavanilles referred *A. crenatiflora* without question to his *A. parvifolia.* Both names are common on herbarium specimens, but there is no question as to which is the older. There is considerable variation in the leaf characters. The species, as I now understand it, has a rather wide distribution. The following specimens seem to belong to the typical form:

Mexico:

State of Hidalgo, on hills near Tula, *C. G. Pringle,* October 5, 1896 (No. 6541).

State of Chihuahua, near Chihuahua City, *C. G. Pringle,* September 30, 1896 (No. 1073).

Lower California, near Comondu, *T. S. Brandegee,* March 4, 1889, and at San Jose del Cabo, October 4, 1892.

United States:

Texas, in Viejo Mountains, *V. Havard,* October 5, 1883 (No. 6).

The following form, here described as a variety, may yet prove to be a good species:

Anoda crenatiflora glabrata var. nov.

Leaves glabrous on both sides, or with a few simple or stellate hairs on the veins; sepals usually more acuminate than in the type, otherwise very similar.

Collected by J. N. Rose in fields near San Juan Capistrano, State of Zacatecas, August 20, 1897 (No. 2444), and on the side of the mountain at Bolaños, September 10 to 19 (No. 291[illegible]). Here also belongs Dr. Palmer's No. 128 (1885) from southwestern Chihuahua.

Anoda cristata (L.) Schlecht. Linnæa, **11**:210. 1837. *Sida cristata* L. Sp. Pl. **2**:684. 1753. *Anoda hastata,* most authors, not Cav. Monadelph. Diss. **1**:38, *t. 10, f. 3.* 1785.

A variable and widely distributed species. Collected by J. N. Rose near Huejuquilla, Jalisco, August 24, 1897 (No. 2523); Mesquitec, Zacatecas, August 26 (No. 3579); near Plateado, Zacatecas, September 2 (Nos. 2709 and 3632); at Bolaños, Jalisco, September 10 to 19 (No. 2909), and in the City of Mexico, September 27 (No. 3071).

Anoda hastata Cav. Monadelph. Diss. **1**: 38, *t. 10, f. 3.* 1785. *Anoda acerifolia* DC. Prodr. **1**:459. 1824. Same of most authors. FIGURE 28.

This species, while much resembling *A. cristata,* seems to be perfectly distinct. I have grown it for several years and find that the fruit characters are constant. The lateral walls of the carpels are not entirely absorbed, as in *A. cristata,* but are simply perforated, the seed remaining within the carpel and dropping with it. The habit of this species is more procumbent. Cultivated specimens have many spreading branches, often 12 to 18 dm. long.

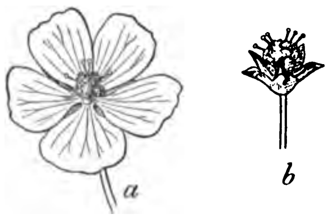

FIG. 28.—*Anoda hastata.* *a,* Flower; *b,* same with petals removed—both natural size.

Anoda pentachista Gray, Pl. Wright. **2** : 22. 1853.

Found in old field growing with *A. crenatiflora* var. about San Juan Capistrano, Zacatecas, August 20, 1897 (No. 3762).

PERIPTERA.

The genus Periptera[1] has recently been treated by both Schumann and E. G. Baker, our best authorities on this order, as only of subgeneric importance. The discovery of a second species showing even more marked difference from Anoda than the first strengthens the reasons for considering Periptera as distinct from Anoda.

The flowers are of the Malvaviscus and Hibiscus type, and in this respect it differs more from Anoda than Anoda does from Sida.

Bentham and Hooker, who merely list the genus among the doubtful ones of the order, state that it is very similar to species of Abutilon.

The previous history of the genus is that of the one known species. It has been referred to three different genera and published under six combinations.

The history, in detail, is as follows: In 1813 it was named *Sida rubra* by Tenore, but not described; in 1814 it was figured and described by Sims as *Sida periptera;* in 1816 it was named *Anoda punicea* by Lagasca, and in 1821, by Kunth, *A. incarnata.* In 1824, De Candolle identified the first three names, constructing for them the genus Periptera and using the combination *P. punicea;* but De Candolle also continued Kunth's name under Anoda. This dual course was followed by Don (in 1831) and Hemsley (in 1879).

Dr. K. Schumann, in the Flora Brasiliana (fasc. 109, p. 357), made Periptera a section of Anoda, and has been followed by Mr. E. G. Baker (1892) and others. As I have stated above, it appears to me that it deserves to be restored to generic rank.

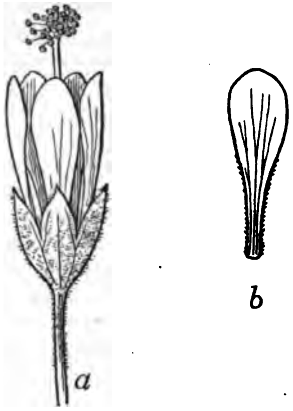

FIG. 29.—*Periptera periptera.* *a*, Flower; *b*, single petal—both natural size.

Mr. Baker has seen my specimens, and in the light of better material agrees with me in the advisability of restoring Periptera. He says: "I followed K. Schumann in reducing it to a section of Anoda. Of course there are very obvious differential characters, the most noticeable being the exserted staminal column."

The two species, then, are as follows:

Periptera periptera (Sims) Rose. *Sida rubra* Tenore, Cat. Ort. Nap. 96. 1813. Name only. *Sida periptera* Sims, Bot. Mag. **40**: *t. 1644.* 1814. *Anoda punicea* Lag. Nov. Gen. 21. 1816. *Anoda incarnata* H. B. K. Nov. Gen. et Sp. **5**: 266. 1821. *Periptera punicea* DC. Prodr. 459. 1824. *Sida malvaviscus* DC. Prodr. **1**: 459. 1824. FIGURE 29.

Collected by J. N. Rose in the mountains west of Bolaños, Jalisco, September 15 to 17, 1897 (No. 2945), and between Bolaños and Guadalajara, September 21, 1897 (No. 3046).

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[1] DC. Prodr. **1**: 449. 1824.

Périptera macrostelis Rose, sp. nov. PLATE XIX.

"A vine-like shrub," 24 to 45 dm. high; young branches clothed with a short, stiff pubescence, older branches somewhat glaucous; leaves cordate at base, somewhat 3-lobed, the two lateral lobes short and obtuse, the central one elongated, acuminate, crenate, nearly glabrous above, slightly stellate beneath; inflorescence a terminal somewhat leafy panicle; pedicels 20 mm. long or less; involucral bracts none; calyx cup-shaped, the tube 4 mm. long, lobes ovate, 2 mm. long, densely stellate and more or less villous, not angled; corolla erect, "orange red;" petals more or less convolute when in flower, wedge-shaped, somewhat one-sided, somewhat pubescent without, slightly ciliate on the margin, 10 mm. long, 8 mm. broad at widest point; stamen tube slender, much elongated, 25 mm. broad at widest point, slightly cleft at the tip; styles 6, slightly capitate; cells of ovary one-ovuled, the ovules pendulous; carpels small, somewhat 3-toothed at apex, the sides reticulated, the walls disappearing between the reticulations.

Collected by Mr. E. W. Nelson near San Sebastian, State of Jalisco, altitude, 3,800 to 5,000 feet, March 16, 1897 (No. 4086).

EXPLANATION OF PLATE.—Fig. 1, a flowering branch; fig. 2, a leaf; fig. 3, a petal; fig. 4, a carpel; figs. 1 and 2, natural size; figs. 3 and 4, scale 5.

HIBISCUS.

Hibiscus biseptus Wats. Proc. Am. Acad. **21**: 418. 1886.

The lower leaves are ovate, not at all lobed; upper leaves 3-lobed.

Collected by J. N. Rose on the road between San Juan Capistrano and Huejuquilla, Jalisco, August 23, 1897 (No. 2504), and at Bolaños, September 10 to 19 (No. 2906). Our only other specimens are the type specimens collected by Dr. E. Palmer in the State of Chihuahua. The species is a tropical one and may be expected in many of the hot interior valleys.

Hibiscus coulteri Harvey; Gray, Pl. Wright. **1**: 23. 1852.

Collected by J. N. Rose near Guaymas, Sonora, June 8, 1897 (No. 1255); also a very large-flowered form by Dr. E. Palmer at Topolobampo, State of Sinaloa, September 15 to 25, 1897 (No. 192).

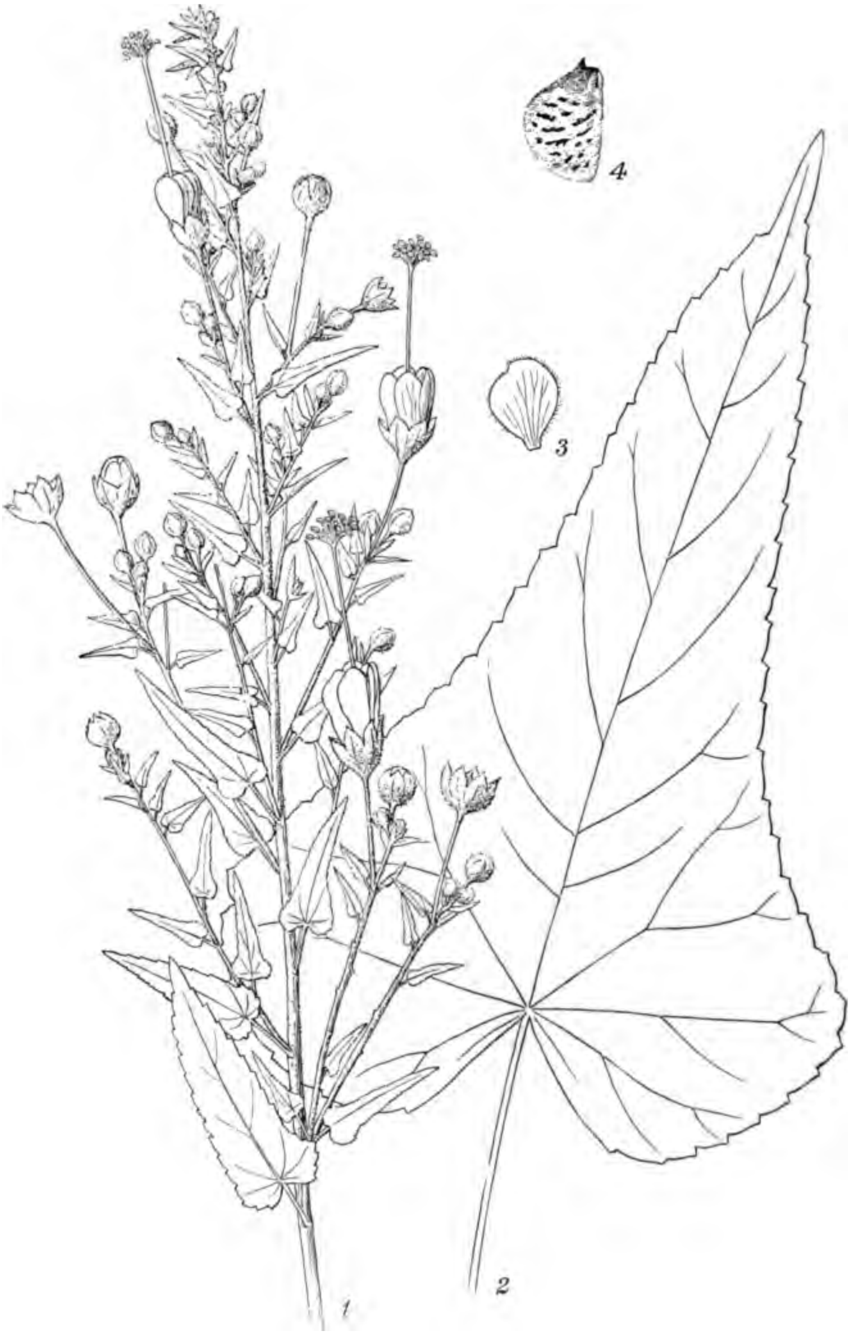
Hibiscus manihot L. Sp. Pl. **2**: 696. 1753.

I saw only one plant of this very showy Hibiscus. It was growing in the plaza of Acaponeta, Tepic, July 31, 1897 (No. 1911). The leaves are 3 to 5 parted (nearly to the base); the segments are linear and sometimes 9 inches long. The flowers were lemon-colored and nearly 6 inches broad. The species has heretofore been unrepresented in the National Herbarium.

The following note from the pen of W. Watson, of Kew, which appeared in the Garden and Forest for 1897, will be of interest:

"When treated as a greenhouse plant this old annual species of Hibiscus grows to about a yard in height, and is pyramidal in shape, clothed with palmately lobed, dark green, smooth leaves, about 6 inches long, and produces in autumn handsome cup-shaped flowers, 5 inches in diameter, colored golden-yellow with purple center. It is a native of China, but has long been naturalized in Bengal, and is commonly cultivated in tropical countries. It was introduced into English gardens nearly two hundred years ago, and has been tried as a summer bedding plant. Recently it has attracted attention through some plants that were sent to a meeting of the Royal Horticultural Society by Mr. Lambert, of Cookham, who sowed the seeds in heat in February and grew the plants outside in summer. They were shown in August and received an award of merit."

Peter Henderson & Co. in this country have been cataloguing this species for the last three years as "Japanese manihot."



PERIPTERA MACROSTELIS Rose.

Sida acuta carpinifolia (L. f.) Schum. in Mart. Fl. Bras. **12**, pt. 3: 326. 1891. *Sida carpinifolia* L. f. Suppl. 307. 1781.

Collected by J. N. Rose, at Mazatlan, June 17 to 19, 1897 (Nos. 1377 and 3102); at Acaponeta, Tepic, June 28 (No. 1491), July 30 (Nos. 3290 to 3292); at Rosario, Sinaloa, July 6 to 10 (No. 3160); and near Colomas, July 18 (No. 3198). At Rosario I saw this plant made into rude brooms.

Besides the above I collected, near Dolores. Tepic, August 7, 1897 (No. 424), specimens which, since the fruit is not mature, it seems best for the present to refer as a form to this species, though they do not agree with it in all respects. They may be described as follows: Low shrubs; young branches covered with large stellate hairs; leaves oblong, rounded at base, obtuse and apiculate, pubescent above, with simple hairs, but beneath densely stellate-pubescent, 3 to 7.5 cm. long on very short petioles; stipules linear, twice as long as the petioles; flowers solitary on peduncles 2 cm. long; buds shortly oblong, pubescent, with simple hairs, long-acuminate, strongly angled at base; petals purplish at base; capsule truncate; carpels 7, faintly reticulated on the back, muticose (?).

Sida cinerea Baker f. Contr. Nat. Herb. **3**: 311. 1895.

Collected by J. N. Rose, at Acaponeta, Tepic, June 23 to 30, 1897 (No. 3131).

This species has heretofore been known only from the type specimens which came from Tepic.

Sida diffusa H. B. K. Nov. Gen. et Sp. **5**: 257. 1821.

Collected by J. N. Rose, in the State of Durango, August 15, 1897 (No. 2316); at San Juan Capistrano, State of Zacatecas, August 19 (No. 2432); and at Bolaños, State of Jalisco, September 10 to 19 (No. 2904).

Sida hederacea (Dougl.) Torr.; Gray, Pl. Fendl. 23. 1849. *Malva hederacea* Dougl.; Hook. Fl. Bor. Am. **1**: 107. 1830.

Common in gardens near Guaymas. Collected by J. N. Rose, June 5 to 11, 1897 (No. 1208).

Sida holwayi Baker & Rose, sp. nov.

Stems erect 6 to 8 (?) dm. high, covered with coarse spreading stellate hairs and a few longer simple hairs; branches ascending, somewhat naked above; leaf blades oblong, 2.5 to 4 cm. (?) long, rounded at base, rounded or obtuse at apex, crenately toothed, green and somewhat stellate above, paler and more densely stellate beneath; petioles shorter than the blades; stipules filiform, deciduous; flowers 1 to several in the lower axils, becoming more or less glomerate towards the apex of the branch, intermixed with purplish filiform bracts (stipules); fruiting pedicels 6 to 8 mm. long; calyx 6 mm. high, angled, softly pubescent, with broadly triangular and acute lobes; corolla yellow (?); capsule 6-celled; carpels somewhat reticulated on the back, strongly reticulated on the sides, 2-awned, the body of the carpels 2 to 3 mm. long, twice as long as the retrorsely hispid awns.

Collected by E. W. D. Holway, Cuantla, Morelos, October 12, 1898 (No. 3043).

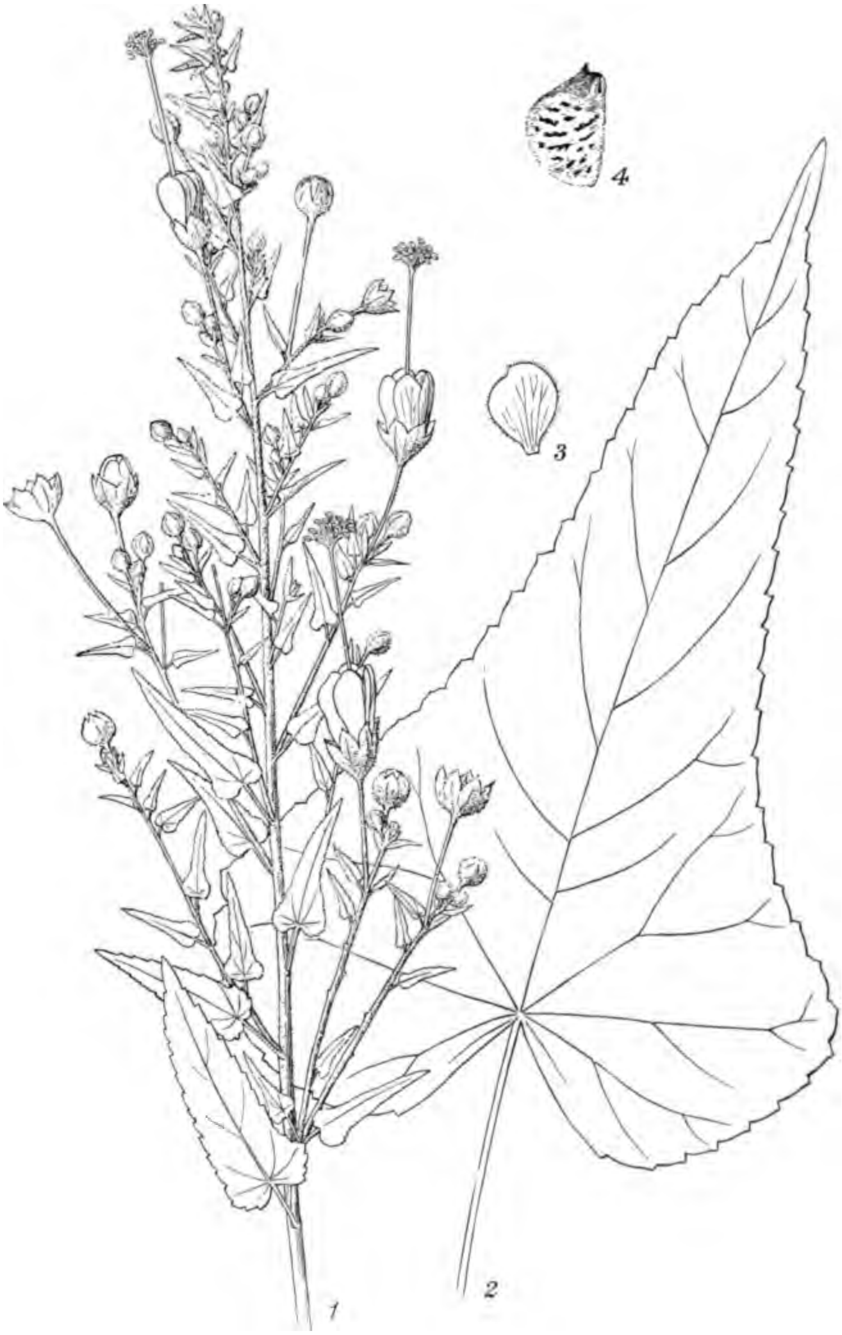
Nearest *S. salviaefolia* Presl, but of different habit and with pubescent broader leaves, the inflorescence more congested towards the tips of the branches, sepals broader, carpels larger and shorter-awned, etc.

Sida neo-mexicana Gray, Proc. Am. Acad. **22**: 296. 1887. Fide Baker f.

Collected by J. N. Rose near Huejuquilla, Jalisco, August 24, 1897 (No. 2537).

Sida salviaefolia Presl, Reliq. Haenk. **2**: 110. 1836.

The type of this species was collected many years ago by Haenke at Acapulco, and had not been collected again until recently, when Dr. E. Palmer (No. 1, 1895–96) obtained it from the type locality. Mr. E. G. Baker in his revision made it a variety of *S. spinosa*, but I believe he now considers it a good species. It is remarkable for the long retrorsely hispid awns of the carpels.



PERIPTERA MACROSTELIS Rose.

Wissadula paniculata Rose, sp. nov.

A small shrub 15 to 24 dm. high; leaves ovate, acuminate, cordate at base, 7 to 10 cm. long, short-petioled, somewhat stellate on both surfaces; flowers in dense terminal panicles; pedicels slender, 1 to 2 cm. long, jointed a short distance below the flower; calyx 6 mm. long; sepals triangular, shortly acuminate, stellate; petals yellow; carpels about 8, strongly apiculate.

Collected by Dr. E. Palmer near Ymala, Sinaloa, September 25 to October 8, 1891 (No. 1743).

This species is near *W. scabra*, but seems to differ in the rougher pubescence of the leaves and calyx, the more acuminate buds and sepals, smaller calyx, and smaller and strongly apiculate carpels.

Wissadula acuminata Rose, Contr. Nat. Herb. **5**:144. 1897.

The type specimen (Type No. 1515) is in the National Herbarium.

Wissadula holosericea (Scheele) Garcke, Zeitschr f. Naturw. **63**:124. 1890; *Abutilon holosericeum* Scheele, Linnæa, **21**:471. 1848.

Our material under this name seems to represent 3 forms, but until a much fuller suite of specimens can be examined it seems best to leave them all undisturbed. The slender sepals appear to be associated with the blunter carpels and vice versa. *A. holosericeum* var. (Palmer's No. 112) has nothing to do with this species, but is a good *Abutilon*.

Wissadula pringlei Rose, Contr. Nat. Herb. **3**:312. 1895.

The type specimen (Type No. 475) is in the National Herbarium.

Wissadula trilobata (Hemsley) Rose; *Abutilon trilobatum* Hemsley, Diag. Pl. Nov. pt. **2**:24. 1879.

We have a duplicate type (Type No. 184) of this species in the National Herbarium which possesses all the peculiarities of the genus Wissadula as it has been so aptly described by Dr. Robinson in the Synoptical Flora. Mr. Hemsley states that the cells are often 5 or 6 ovuled, but all those which I have examined have 3 ovules, two in the upper and one in the lower section of the cell, as is always found in this genus.

Collected by Parry & Palmer, near San Luis Potosi, 1878 (No. 81), and more recently by A. Dugès, near Guanajuato, September, 1889 (No. 287).

Here may yet be referred *W. acuminata* Rose, but, as the specimens at hand show a slight difference, it seems best to keep them distinct until more material is collected of both.

In my discussion of *Wissadula hirsutiflora* and its forms, in 1895,[1] I suggested that it contained several good species, and that they seemed to indicate a good subgenus. A recent review of this material confirms the results of my previous study, and I now feel warranted in disposing of them as follows:

BASTARDIASTRUM Rose, § nov.

Carpels 3, rounded at apex; stamens cleft to the base; flowers violet.

Wissadula hirsutiflora (Presl) Rose, Contr. Nat. Herb. **1**: 306. 1895. *Bastardia hirsutiflora* Presl, Reliq. Haenk. **2**: 112. 1836.

Collected by Dr. E. Palmer at Colima, Colima, February 27 and 28, 1891. These specimens have been identified by Mr. E. G. Baker of the British Museum. The type is reported from Acapulco, but both Palmer and Nelson have recently visited this port without being able to find the species.

Wissadula cincta (Brandegee) Rose; *Abutilon cinctum* Brandegee, Zoe, **3**: 348. 1893.

The type collected by Mr. T. S. Brandegee in 1892 comes from Las Durasnellas, State of Sonora. A fragment (Type No. 194) is in the National Herbarium. The plant had been previously collected by Dr. E. Palmer (in 1890) near Alamos, same State (No. 381), and has since been collected by E. A. Goldman at Alamos (January 29, 1899;

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[1] Contr. Nat. Herb. **1**:306.

No. 306). The following note, taken from a letter of Mr. Brandegee, shows that his specimens possess the characters of the genus as well as of this section:

"In *Abutilon cinctum* there is no antheriferous column proper; each one of the carpels is transversely septate, the upper part bearing two collateral seeds and the lower cell one. Very little of it was collected, and I can give you only the fragments inclosed in this letter."

Wissadula tricarpellata Robinson & Greenman, sp. nov.

Stems terete, lignescent below, finely tomentose-pubescent, with short simple (viscidulous?) hairs and somewhat scabrous; the surface in age slit with numerous fine longitudinal linear depressions, apparently the result of the spreading of the cortical fibers; leaves ovate, gradually narrowed to a caudate acumination, serrate-dentate, green and finely stellate-pubescent on both surfaces, slightly paler beneath, usually marked above with a small dark-purple spot at the origin of the (5 to 7) nerves, cordate at the base, 6 to 10 cm. long, 3.5 to 5 cm. broad; petioles 3 to 7 cm. long, tomentose; stipules and bracts filiform, pubescent, caducous; flowers numerous, borne in a large, loose, racemose panicle; pedicels 0.6 to 2 cm. long; calyx campanulate, stellate-tomentose upon the outer surface; segments ovate-lanceolate, attenuate, 4 to 5 mm. long, somewhat exceeding the tube; petals obovate, cuneate, essentially entire, 7 mm. long, densely stellate-pubescent near the base upon the outer surface and margins, in dried specimens bluish; stamineal tube 1.7 mm. long; style deeply 3-parted; divisions pubescent below; ovary and capsule tomentose; ovules 3 in each cell; seeds dark brown, 2 mm. in length, inconspicuously verrucose.—Collected by C. G. Pringle on a moist hillside at Tequila, Jalisco, October 17, 1893, No. 4578 (type number), and September 30, No. 4610 in part. Both numbers were distributed with Mr. Pringle's sets of 1893. Unfortunately, the material under No. 4610 seems to have been confused and to consist in some sets of a Sida near to if not identical with *S. alamosana* Wats. This material may be distinguished from the Wissadula, here described, not only by the well-known carpellary difference between the genera Sida and Wissadula, but by the pubescence of the leaves, which is longer and chiefly simple.

Wissadula wissaduloides (Baker f.) Rose; *Abutilon wissaduloides* Baker f. Contr. Nat. Herb. 3: 312. 1895.

The type of this species is in the National Herbarium (type No. 482). The species is only known from Dr. Palmer's specimens from Ymala, State of Sinaloa, 1891 (No. 1720).

MISCELLANEOUS SPECIES.

Bombax palmeri Wats. Proc. Am. Acad. **22**: 399. 1887.

A tree 4.5 meters or more high, with a large spreading top; bark very scaly, but finally falling, leaving a smooth, reddish trunk; leaflets mostly 5, clothed when young with a dense stellate tomentum on both sides, becoming nearly glabrate above in age; petals 5, 10 cm. or more long, thickish, densely stellate; stamens numerous, united at base into a tube 2 cm. long.

This species has heretofore been known only from Palmer's and Pringle's collections about Guadalajara. It proves to be one of the commonest trees in the tropical district from Rosario to Acaponeta and Tepic, eastward to the mountains, and in the tropical valleys of the interior. The trees are usually found on rocky hillsides at from 200 feet to 3,600 feet altitude. It flowers some time during the dry season (October to June), fruiting just before the beginning of the rainy season. Flowers heretofore have not been collected, and mine are poor, consisting only of old and withered ones.

Specimens were collected near Acaponeta, Tepic, June 23, 1897 (No. 1451), and near Colomas, Sinaloa, July 21 (No. 3215). Trees were noted on the east side of the west range of the Sierra Madre at an altitude of 3,600 feet.

Ceiba casearia Medic. Malvenfam. 16. 1787.

A few large trees, 20 meters high with a trunk 15 dm. in diameter, were seen near Concepcion, Tepic, July 29, 1897; J. N. Rose (No. 1887). The trees are said to flower in the dry season.

This is one of the tree-cottons of which the Mexicans use the fiber in pillows, etc.

Ceiba grandiflora Rose, Contr. Nat. Herb. **1**: 308. 1895.

This Ceiba is a common tree throughout tropical western Mexico. It does not flower during the rainy season, or only sporadically, and my specimens therefore chiefly show foliage. The leaves being taken at various times throughout the rainy season show great variation in texture, pubescence, etc. My specimens may all belong to one species, although I have referred them to two. Full material of all the Mexican species should be collected so as to enable someone to redescribe them.

Collected by J. N. Rose near Rosario, July 6 to 10, 1897 (No. 3161); near Colomas, Sinaloa, July 16 (No. 1705), and between San Juan Capistrano, Zacatecas, and Huejuquilla, Jalisco, August 23 (No. 2494).

Ceiba tomentosa (Robinson) Britten & Baker, Journ. Bot. **34**: 175. 1896. *Eriodendron tomentosum* Robinson, Proc. Am. Acad. **29**: 314. 1894.

Collected by J. N. Rose at Bolaños, September 10 to 19, 1897 (Nos. 2934 and 3687), and between Bolaños and Guadalajara, Jalisco, September 22 (No. 3096).

I have referred these specimens here as they come from the region of the type specimens. In the field I did not distinguish this species from the preceding, but the herbarium specimens show a difference in pubescence and texture which seems to be constant.

Gossypium barbadense L. Sp. Pl. **2**: 697. 1753.

A shrub or large bush 5 to 8 feet high. It is cultivated in many places in Mexico for the cotton. Specimens were obtained from the following places:

La Paz, Lower California, June 14, 1897 (No. 1306); in yard at Huasemote, August 14 (No. 2285); on the road between San Juan Capistrano and Huejuquilla, Jalisco, August 23 (No. 2498), and in yard at Bolaños, Jalisco, September 10 to 19 (No. 3697).

Horsfordia newberryi (Wats.) Gray, Proc. Am. Acad. **22**: 296. 1887. *Abutilon newberryi* Wats. Proc. Amer. Acad. **11**: 125. 1876.

This is a common shrub on the low hills about Guaymas.

Collected by J. N. Rose, June 5 to 11, 1897 (No. 1262).

Kosteletzkya paniculata Benth. Pl. Hartw. 285. 1848.

The type was collected at Bolaños, Jalisco, by Hartweg. I did not see the plant at this place, but collected specimens between Bolaños and Guadalajara, September 22, 1897 (No. 3064).

Malva parviflora L. Amoen. Acad. **3**: 416. 1756.

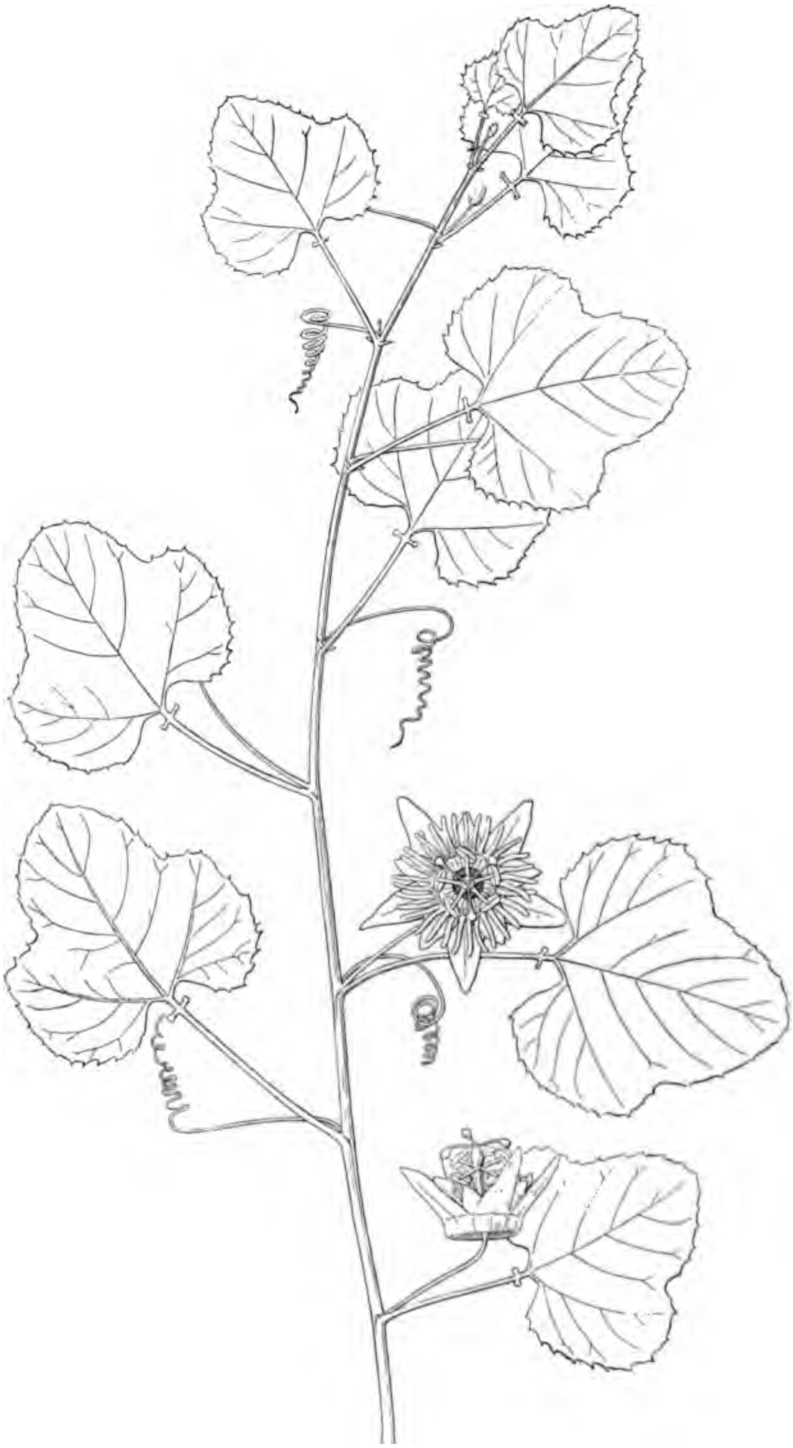
Collected by J. N. Rose at Colomas, July 16, 1897 (No. 1723), and between Concepcion and Acaponeta, July 30 (No. 1905).

This is called by the Mexicans "malva castilla."

Malvastrum greenmanianum Rose, sp. nov.

Stems 5 to 8 feet high, sparingly branched; plant more or less stellate-pubescent throughout; leaves ovate to orbicular in outline, cordate at base, 3-lobed, with the lobes acute, somewhat unequally crenate, the larger ones 5 to 6 inches long (on petioles 4 to 6 inches long), becoming much smaller above; flowers in dense axillary clusters or short spikes, or sometimes in a terminal interrupted spike, either naked or leafy; bractlets 3, filiform; calyx 3 lines broad, becoming larger in fruit; lobes ovate, acute, 1 line long; petals white, small (1½ lines long), nearly orbicular, rounded at apex, somewhat cuneate at base; carpels usually 9; 1 line in diameter, smooth except a small tuft of hairs near the tip. Collected by Mr. C. G. Pringle in the pedregal of the Valley of Mexico, October 19, 1896 (No. 6582).

This species is very near *M. schaffneri* Wats., but differs somewhat in the shape



PASSIFLORA COLIMENSIS Masters & Rose.

of the leaves, in the calyx lobes being less ovate, acuminate, the calyx less densely stellate-tomentose, the fruit slightly different, etc. This species is named for Mr. J. M. Greenman, who has assisted in separating it from *M. schaffneri*.

Malvastrum tricuspidatum Gray, Pl. Wright. 1: 16. 1852.

Collected by J. N. Rose between Rosario and Concepcion, Sinaloa, July 27, 1897 (No. 3263); at Rosario, July 11 (No. 1597), and at San Juan Capistrano, Zacatecas, August 20 (No. 2446).

Melothria scabra Naud. Ann. Sci. Nat. ser. 5, 6: 10. 1866.

Collected by J. N. Rose near Acaponeta, Territorio de Tepic, June 23 to 30, 1897 (No. 3142).

A rather peculiar form, with leaves nearly orbicular in outline, either slightly or deeply 5-lobed. A somewhat similar form was collected by Dr. Palmer near Acapulco, Guerrero, in 1895.

Robinsonella discolor Rose & Baker f., sp. nov.

Tree 6 to 9 m. high, glabrous, with brownish gray cortex; leaves ovate, cuspidate, subacuminate, blunt at the apex, cordate or subcordate at base, sometimes unequal-sided, 4 to 5 cm. long, 2.5 to nearly 4 cm. broad, on petioles 1 to 1.5 cm. long, discolorous (covered with a fine but dense tomentum), green above, canescent below; sepals ovate; petals white, 7 mm. long; fruit borne on pedicels, often about 2 cm. long toward the extremities of short lateral branchlets and at the apex; pedicels articulated about the middle, solitary or in pairs; calyx about two-thirds the length of the carpels; sepals ovate, acute, puberulous; carpels about 12, stellately hairy, especially on the back, not quite 1 cm. long; seed dark brown, subtriangular, hairy in parts.

Collected by Mr. C. G. Pringle on limestone hills, Las Palmas, San Luis Potosi, altitude 90 meters, April 27, 1894 (No. 5767), and March 2, 1899 (No. 8007).

This species differs from *R. cordata* Rose & Baker f. in not having villous petioles, in the color and character of the pubescence on the leaves, etc. Subscribers to Mr. Pringle's elegant sets of Mexican plants will doubtless find it in this year's distribution. Mr. Pringle states that this species is a slender tree found on the mountains of eastern San Luis Potosi, thence to Tampico.

Adding this species to those described in Garden and Forest for June, 1897, the genus will now consist of *R. cordata* Rose & Baker f., *R. divergens* Rose & Baker f., *R. lindeniana* (Turcz.) Rose & Baker f., and *R. discolor*. The type of the last named will be found in the U. S. National Herbarium, Washington.

Fragments of still another species have recently been sent to Mr. Rose from Honduras, and while there is no question as to its generic position and its distinctness from the four other species, yet it seems best to withhold it until further material has come to light. Collectors in Central America and curators of Herbaria will confer a great favor if they can communicate any material which will help us diagnose this species fully.

NOTES ON PASSIFLORA.

Passiflora colimensis Masters & Rose, sp. nov. PLATE XX.

Annua? debilis ramis sulcato-striatis, setulosis; petiolis ad 5 cm. gracilibus versus apicem biglandulosis, laminis circa 4 cm. long. 5 cm. lat. membranaceis pilosulis seu glabrescentibus basi cuneatis cordato-bilobis (lobis rotundatis), 3-nerviis ad medium 3-lobis lobis obtusiusculis ad margines remote dentatis; stipulis minutis deciduis; pedunculis axillaribus petiolis brevioribus bracteis parvis setaceis remotiusculis munitis; floribus circa 4 cm. diam. tubo lato glabro poculiformi; sepalis herbaceis e basi lato lanceolatis; petalis albidis sepalis dimidio brevioribus; corona fauciali filamentosa filis 1-seriatis petalis aequilongis liguliformibus basi violaceo fasciatis; corona media membranacea inflexa margine dentata; ovario glabro elliptico, stylis liguliformibus apice stigmatoso clavatis; fructu baccato, $\frac{3}{4}$ cent. long. 3 cent. lat. glabro; seminibus complanatis foveolatis.

This species is near *P. sicyoides* and *P. bryonoides*, but specifically very different. The specimens have been carefully compared both at Kew and at Washington, but there is nothing like it in either collection.

Collected by Dr. E. Palmer in July, 1897 (No. 283), at the city of Colima, where it is said to grow in shady woods, running over low bushes or trailing over the ground. Dr. Palmer states that the flowers are white with blue markings and very showy, and that the fruit is sometimes eaten.

Passiflora foetida L. Sp. Pl. **2**: 959. 1753.

This is a very common species. Collected by J. N. Rose at Acaponeta, Tepic, June 25, 1897 (No. 1466); between Pedro Paulo and San Blascito, Tepic, August 4 (No. 1998); near San Juan Capistrano, Zacatecas, August 20 (No. 2443), and at Bolaños, Jalisco, September 11 (No. 2894).

Passiflora foetida arida Masters & Rose, var. nov.

A very remarkable form, and perhaps distinct from *P. foetida*, but for the present it seems best to treat it as a variety.

Specimens collected by J. N. Rose at Guaymas, Sonora (No. 1206), may be described as follows: Stems covered with a soft, whitish, short pubescence; petioles very short; leaves nearly orbicular in outline, deeply 3-lobed, the lobes nearly equal, rounded at apex, very thick in texture, somewhat reticulated beneath, densely and velvety pubescent on both sides, slightly or not at all glandular; involucral bracts lanate, more or less glandular.

Here I am inclined to refer the following specimens, although they differ somewhat in the shape and cutting of the leaves:

Edward Palmer's No. 91, from Guaymas, Sonora, 1887; F. S. Maltby's No. 206, from Hermosillo, Sonora, June 10, 1897; J. N. Rose's No. 1318, from La Paz, June 14, 1897; T. S. Brandegee's plant, from Comondu, Lower California, March 11, 1889, and his No. 333, from San Jose, Lower California, March to June, 1887. This form is confined to the most arid parts of western Mexico.

Passiflora foetida hastata (Bertol.) Masters in Mart. Fl. Bras. **13**, pt. 1: 583. 1872.

P. hastata Bertol. Fl. Guatim. 27. 1840.

Leaves soft-velvety, the central lobe much elongated.

Here I would refer specimens collected by Dr. E. Palmer at Acapulco, Mexico, in 1894 and 1895 (Nos. 306 and 315).

Passiflora mexicana A. Juss. Ann. Mus. Par. **6**: 108, *t. 38, f. 2.* 1805.

Collected by J. N. Rose in the State of Jalisco on the road between Bolaños and Guadalajara, September 19, 1897 (No. 3017).

Passiflora serratifolia L. Sp. Pl. **2**: 955. 1753.

Collected by Mr. E. A. Goldman in the State of Puebla, January 31, 1898 (No. 36).

This is *P. serratifolia* as understood by Masters, but the leaves are less serrate than in Linnæus's figure.[1]

Passiflora sicyoides Cham. Linnæa, **5**: 88. 1830.

Collected by J. N. Rose in the mountains west of Bolaños, September 15 to 17, 1897 (No. 2965).

My specimens are referred to *P. sicyoides* on the authority of Dr. Masters. They differ from the description of *P. sicyoides* in several important respects. In my specimens the leaves are equally 3-lobed, the lobes being rounded or occasionally acute, not glandular at base, etc., while *P. sicyoides* is described as having the lobes triangular and acuminate, the central one elongated and biglandular at the sinus; the petiolular glands in my plant are globular, sessile or nearly so, and not club-shaped, etc. The seeds are also very differently marked from those found on Guatemalan specimens so labeled in the National Herbarium.

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[1] Amoen. Acad. **1**: *t. 10, fig. 1.*

The type of *P. sicyoides* was collected near Jalapa by Schiede and Deppe.

Passiflora suberosa L. Sp. Pl. **2**: 958. 1753.

Collected by J. N. Rose in the State of Durango, August 15, 1897 (No. 3504), and in the Sierra Madre west of Bolaños, September 15 to 17, 1897 (No. 2946).

These two collections, although both referred to *P. suberosa*, seem to be specifically distinct.

The latter specimens have deeply 3-lobed leaves, the lobes very much elongated; the former has ovate leaves, but slightly 3-lobed, the lobes ovate. Dr. Masters thinks this is "an extreme form of *suberosa*, or perhaps distinct."

SYNOPSIS OF THE NORTH AMERICAN SPECIES OF WALTHERIA.

Until recently the National Herbarium has possessed but two species of Waltheria, namely, the common *W. indica* and *W. detonsa*. Recent botanical activity has brought to light all of the six species listed by Hemsley in the Biologia Centrali-Americana, except the little-known *W. hirsuta*, as well as three undescribed species, which are characterized below. The following key has been constructed after a careful study of the material in the Gray, Donnell Smith, and National Herbaria, and, although it seems reasonably satisfactory, a study of larger collections will doubtless suggest further modifications.

A. § STEGOWALTHERIA. *Stipules large and broad; style terminal; capsule dehiscent by a terminal lid.*

Waltheria operculata Rose, sp. nov.

Herbs, 3 to 6 dm. high, more or less branching, somewhat hairy; leaves oblong, more or less hairy on both sides, somewhat irregularly serrate, acute, 3 to 6 cm. long; petioles 12 to 25 mm. long; stipules obliquely ovate, acuminate, 4 mm. broad at base, 8 mm. long, inflorescence capitate, short-peduncled; heads bracteate; outer bracts broadly ovate, acute, inner ones narrower; calyx turbinate, 6 mm. high, 5-lobed, 10-nerved; lobes acuminate, as long as the tube, clothed with long pilose hairs; petals 5, 7 mm. long, yellow, spatulate, obtuse, slightly sagittate at base, and with slender claws; stamens 5; filaments united to the top; style slender, tapering into a long unbranched appendage; ovary 2-seeded; capsule thin below, but capped with a thick hairy operculum.

This species belongs to Professor Schumann's section Stegowaltheria, of which there have been hitherto only two species described, both from Brazil. It is perhaps nearest *W. bracteosa*, but it has differently shaped stipules, narrower and longer-petioled leaves, shorter peduncles, and filaments united to the top.

Collected by E. W. Nelson between Tapana, State of Oaxaca, and Tonala, State of Chiapas, altitude 200 to 500 feet, August 1 to 3, 1895 (No. 2876).

AA. § EUWALTHERIA. *Stipules filiform; style lateral; dehiscence of capsule loculicidal.*

a. *Leaves thin, acuminate, sharply serrate, soon glabrate.*

Waltheria acuminata Rose, sp. nov.

Stems shrubby; leaves broadly ovate, acuminate, cordate at base, somewhat irregularly serrate, 10 to 12.5 cm. long, including the petiole (2.5 to 3 cm. long), nearly glabrous, or the petioles more or less stellate-pubescent; flowers in small axillary or terminal clusters on short peduncles; calyx turbinate but somewhat 5-angled, strongly 10-nerved, densely stellate-pubescent; lobes 5, half as long as the tube, ovate, acute; petals 5, obtuse, wedge-shaped, tapering into a slender claw, glabrous; stamens 5, glabrous, filaments united to above the middle; style single, glabrous, much longer than the stamens; stigma club-shaped; ovary hairy, 1-celled, 2-ovuled.

Collected by Dr. Edward Palmer near Culiacan, October 25 to November 18, 1891 (No. 1793).

aa. *Leaves not so thin, not acuminate nor sharply serrate; never glabrate.*

b. *Low, rather delicate shrubs or herbs; leaves small; flowers small.*

c. *Calyx tube twice as long as the sepals.*

Waltheria preslii Walp. Repert. **1**:340. 1842. *Waltheria rotundifolia* Presl, Reliq. Haenk. **2**:151. 1836. Not Schrank, 1828.

Very common on the sea beach, often covering large surfaces with its long prostrate stems; flowers yellow. Collected by Dr. E. Palmer near Acapulco, February, 1895 (No. 502).

The type of *W. rotundifolia* was collected at Acapulco by Haenke many years ago, but has not since been collected till now.

cc. *Calyx tube no longer than the sepals.*

d. *Filaments united to the top.*

Waltheria americana L. Sp. Pl. **2**:673. 1753.

Collected by J. N. Rose at Mazatlan, June 17 to 19, 1897 (No. 1376) and at Acaponeta, Tepic, June 23 to 30 (No. 3130).

A common tropical species.

Waltheria detonsa Gray, Pl. Wright, **2**:24. 1853.

Collected by J. N. Rose near San Juan Capistrano, Zacatecas, August 22, 1897 (No. 3448).

dd. *Filaments not united at the top.*

Waltheria hirsuta Presl, Reliq. Haenk. **2**:152. 1836.

This species was collected by Haenke somewhere in western Mexico, but the exact locality is not given. I have not been able to refer any of our Mexican material to it. The species is described as having the leaves ovate, cordate, acute, and 5-nerved, and the flowers purple.

Waltheria acapulcensis Rose, sp. nov.

Apparently a low shrub; branches slender, purplish, stellate-pubescent; upper leaves somewhat elliptical, obtuse, rounded at base, some of the lower ones cordate, 2.5 to 5 cm. long, stellate above, paler and more densely stellate beneath; flowers in sessile or shortly pedunculate clusters; calyx 3 mm. high; sepals equal to the tube, acute; petals yellow, oblanceolate, obtuse, tapering at base into a slender claw; stamens united below for about one-fourth their length.

Collected by Dr. E. Palmer near Acapulco, 1894–95 (No. 218).

Dr. Palmer states that the species is very common in the canyons.

bb. *Tall coarse shrubs; leaves large; flowers large.*

e. *Filaments united to the top.*

Waltheria brevipes Turcz. Bull. Soc. Nat. Mosc. **31**, pt. 1:213. 1858.

Shrub 2.4 to 7.5 dm. high. Calyx 6 mm. long, hairy without; lobes half the length of tube; filaments united to the top; style long and hairy; capsule without operculum. Collected by E. W. Nelson in dry ground in clearings about the outskirts of Tuxtepec, Oaxaca, April 9, 1894 (No. 362).

The type locality is "San Pedro Nolasco." We have nothing like Mr. Nelson's plant in the herbarium. It very closely resembles in habit, foliage, and inflorescence Mr. Charles L. Smith's No. 1087 from isthmus of Tehuantepec, but has a different calyx and stamen tube.

Waltheria rhombifolia Donnell Smith, Bot. Gaz. **23**: 3. 1897.

This species, based on a common plant of Costa Rica, seems not to be specifically different from the above.

ee. *Filaments not united to the top.*

Waltheria glomerata Presl, Reliq. Haenk. **2**: 152. 1836.

Shrub 15 to 24 dm. high; calyx 6 mm. long; sepals broad, 1 mm. long; petals exserted; stamens united only at base.

NOTES ON SOME MEXICAN SPECIES OF THALICTRUM.

While attempting to revise the Mexican and Central American species of Thalictrum I found that there were five very distinct species with peltate leaflets. Only two species with such leaflets had heretofore been described from this region. One of these is the very recent *T. pringlei*, of which we have a duplicate type in the National Herbarium. The other is the *T. peltatum* DC., which was very briefly described in the Prodromus and said to have come from Mexico.

Lecoyer, in his monograph of this genus, cited as belonging to this species specimens from two very widely separated localities, namely, Costa Rica and Agua Calientes. From my knowledge of the flora of these two regions I doubted these references, and the specimens seemed to confirm my suspicions. I could not, however, without knowledge of the type locality and with the very meager characterization in the Prodromus describe definitely what was really *T. peltatum.* This led me to send specimens and a brief note to M. Casimir de Candolle, at Geneva, in whose herbarium is deposited the type of *T. peltatum.* M. de Candolle replied at some length and inclosed a tracing of the foliage and akenes. His letter is so clear and exhaustive that it seems advisable to publish the correspondence in full, as it can not fail to be of interest and of value when a more exhaustive study of this genus is made.

FEBRUARY 27, 1899.

M. CASIMIR DE CANDOLLE,
Cour de St. Pierre 3, Geneva, Switzerland.

MY DEAR SIR: I am about to trouble you once more, and this time with a Thalictrum. *Thalictrum peltatum* was described in the Prodromus, volume 1, page 11, but with no more definite locality than "Mexico." Lecoyer cites two localities for this species—Costa Rica and Agua Caliente. We have a specimen in the National Herbarium, from Guatemala, which seems to answer his description, but I am not sure that this is the same plant as described in the Prodromus. I have five specimens with peltate leaflets, and at least three of them are undescribed. It is very important to make out definitely what is the true *T. peltatum.* I inclose leaflets and fruit of all these five species, and if you can refer any one of these definitely to *T. peltatum* it will be a great help to me. I should like, indeed, to have a fragment from your specimen, but since I know how precious these plants are, I do not feel as though I ought to ask for it.

Yours, very truly,

J. N. ROSE.

3 Cour de St. Pierre,
Geneva, March 12, 1899.

Dear Sir: Having examined the five specimens of Thalictrum recently sent by you, I arrive at the following conclusions:

1. Pringle's No. 7448 is to be referred to the *peltatum* DC. Its leaflets are of the same shape and nearly of the same size with those of that species and glabrous as they are, as you may see in the subjoined tracing of one of the leaves of the Prodromus type. True it is that one of the fruits accompanying that in 7848 bears a rather long style; but I must point out to you the fact that, as shown in my tracing, the fruit of the *peltatum* when young has also a very long style, which afterwards gets broken, so that only part of it remains at the top of the fruit when ripe.

2. *T. jaliscanum* (Rose No. 2840) and the *Pringlei* (Pringle No. 2478) have both much smaller leaflets than the *peltatum* DC.; but this may be due to their having been gathered higher on the plants on superior and smaller leaves, as these leaflets also are quite glabrous; and finally as the fruits of both specimens agree with those of the *peltatum*, I suggest that those species are perhaps mere varieties of the latter.

3. Your *T. cuernavacanum* (Pringle's No. 7238) really seems to me to be a distinct species, on account of its smaller and pubescent leaflets, although its fruits much resemble that of *T. peltatum.*

4. The Guatemala specimen, labeled *T. peltatum* (Heyde No. 164), also looks as a distinct species, on account of its strigulose fruits and leaflets.

Availing myself of your kind permission to do so, I shall retain those five specimens, much regretting on my side not to be able to supply you with any fragment of the already too meager Prodromus type.

These Thalictrums have a very great interest for me, being to my knowledge (with *T. ichangense* Lec.) the only plants having composite leaves with peltate leaflets. I have already drawn attention to this irregularity in the last sitting of the British Association at Bristol.

I remain, yours, very truly,

(Signed) C. De Candolle.

KEY TO THE MEXICAN AND CENTRAL AMERICAN SPECIES OF THALICTRUM.

a. *Leaflets peltate or subpeltate.*

b. *Akenes at least twice as long as broad.*

c. *Glaucous throughout; akenes tapering at base or with a short but evident stipe, narrowly elliptical.*

d. *Leaflets large, with very broad, shallow crenations.*

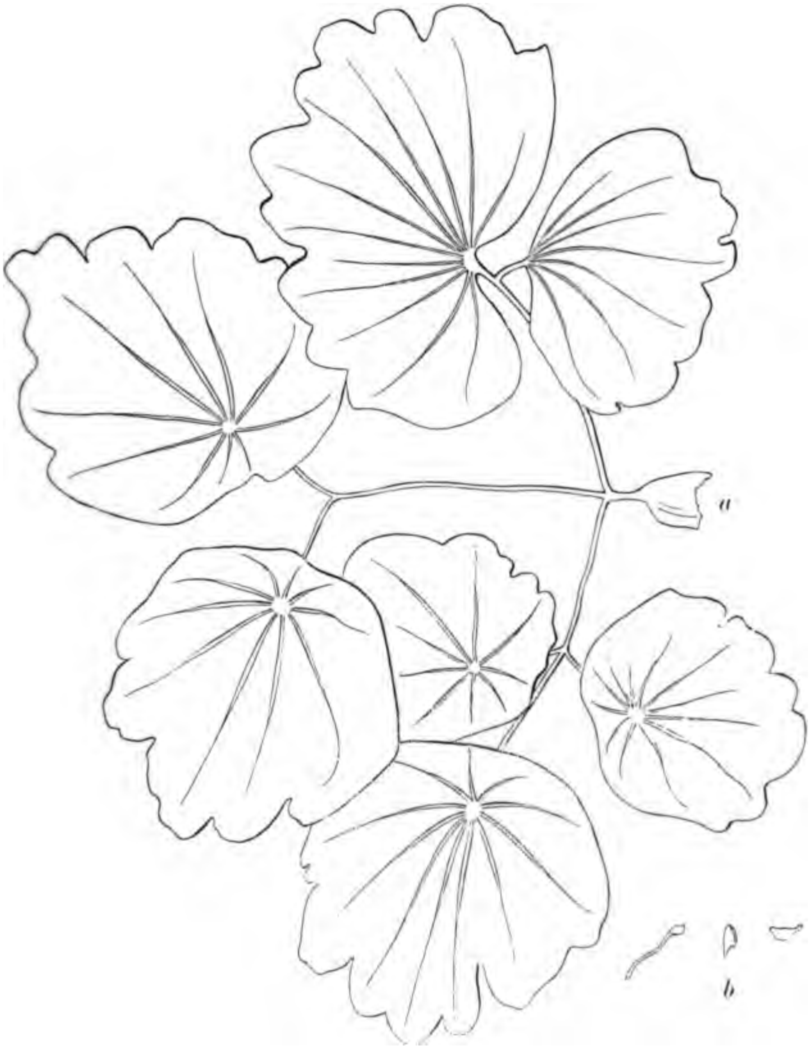
Thalictrum peltatum DC. Prodr. 1: 11. 1824. Plate XXI.

Apparently a tall, coarse plant, glabrous and very glaucous throughout; upper leaves twice ternate; leaflets very large (the upper ones 8 cm. in diameter), peltate, orbicular, with a few large crenations or lobes above, nearly entire below, rather strongly veined, pale on both sides; inflorescence an open panicle, 2 dm. long (in the only specimen seen); fruit somewhat oblong, 5 to 6 mm. long, tapering at base (almost stipitate); one edge nearly straight, the other rounded; the sides with 2 or 3 nearly parallel nerves either distinct or united by cross nerves; style very long (12 mm. or more) and somewhat persistent.

Collected by C. G. Pringle on bluff of barranca above Cuernavaca, Morelos, August 23, 1897 (No. 7448), and distributed as *T. pringlei*. It differs from *T. pringlei* in its fruit and foliage.

I have described this species from Mr. Pringle's specimens, since De Candolle's description really applies equally as well to any one of the peltate-leaved species.

PLATE XXI.



THALICTRUM PELTATUM DC.

For the purpose of comparison I have inserted here A. De Candolle's original description:

"T. PELTATUM, floribus polygamis, filamentis filiformibus, antheris longe aristatis, carpellis sessilibus stylo longè aristatis, segmentis foliorum inferiorum peltatis."

Besides Mr. Pringle's plants, the only other specimen of this species known is the type now in the De Candolle herbarium, of which a sketch is here reproduced.

As is seen in the description above, no type locality is given, nor is any indicated on the label of the type specimens. The postscript to C. De Candolle's letter, quoted above, while not conclusive, seems to throw some light on this point, and is as follows:

"The Prodromus type of *Thalictrum peltatum* is labeled thus: 'Mexique M'Alaman 1811.' Now, Alaman was minister of the interior of Mexico and a friend of my grandfather, to whom he has sent many other plants, but I do not know where he collected them."

From this it is seen that Alaman was stationed in the City of Mexico, and it is not improbable that Mr. Pringle's specimens may have been collected at or near the type locality. It is well known that the Cuernavaca region has long been the resort of the wealthy and influential class of the City of Mexico.

EXPLANATION OF PLATE.—a, Leaf; b, fruit with style, the latter broken off. (Tracing made from the type specimen now in the De Candolle herbarium at Geneva, Switzerland, furnished by M. Casimir De Candolle.)

dd. *Leaflets small, with small ovate teeth.*

Thalictrum jaliscanum Rose, sp. nov.

Stems tall, glabrous and glaucous; upper leaves ternate, the leaflets peltate, orbicular, 6 to 10 toothed, glabrous; inflorescence a large open panicle; carpels narrowly elliptical, somewhat cuneate at base, strongly nerved.

Collected by J. N. Rose on the table-land between Colotlan and Bolaños, State of Jalisco, September 7 to 9, 1897 (No. 2840).

cc. *Not at all glaucous; akenes subsessile, one side straight.*

Thalictrum cuernavacanum Rose, sp. nov.

Stems low, 6 dm. high, somewhat branching above, more or less pubescent; leaves 2-ternate; leaflets nearly orbicular, peltate, with broad, rounded, or somewhat apiculate crenations, slightly roughened above, densely puberulent beneath, pale, 45 mm. or less long; flowers in an open panicle, perfect; stamens with short apiculations; styles long; akenes with one side straight, the other curved, narrowed at base, but more strongly towards the apex, the fruit with 3 or 4 nearly parallel ribs sometimes uniting, slightly scabrous, 4 mm. long.

Collected by Mr. C. G. Pringle near Cuernavaca, State of Morelos, 1896 (No. 7238) and 1898 (No. 6878).

bb. *Akenes a little longer than broad.*

e. *Leaves 1 or 2 ternate; leaflets large, orbicular.*

Thalictrum pringlei Wats. Proc. Am. Acad. **25**: 141. 1890.

The type of this species comes from near Guadalajara, State of Jalisco, and was collected by Mr. C. G. Pringle, June 29, 1889 (No. 2478). We have a duplicate type (Type No. 687) in the National Herbarium. Here probably is to be referred Mr. Pringle's No. 2478, with similar data, but described as *T. pubigerum*, which it can not be. Two peculiar forms of this species were collected by me on the west range of the Sierra Madre, and are characterized below.

Thalictrum pringlei reticulatum Rose, var. nov.

Stems low, 3 to 4.5 dm. high, somewhat pubescent; leaves twice ternate; leaflets peltate, nearly orbicular, 12 to 40 mm. in diameter, entire or 3 to 5 angled, puberulent and pale beneath, dark green and glabrous above, strongly netted-veined; inflorescence a narrow terminal panicle; fruiting peduncle nodding; stamens not seen; styles long; akenes glaucous, obliquely lunate, with about 3 lateral nerves.

Collected by J. N. Rose between Pedro Paulo and San Blascito, in the foothills of the Sierra Madre, Territorio de Tepic, August 4, 1897 (No. 1985).

The second form is nearer the type than the above. In the toothing of the leaflets it is much like *T. pringlei*, but the leaflets are not always peltate, and are slightly puberulent beneath, and the anthers have longer apiculations.

Collected by J. N. Rose between Dolores and Santa Gertrudis, August 7, 1897 (No. 3372).

ee. *Leaves 4 or 5 ternate; leaflets small, ovate.*

Thalictrum guatemalense C. DC. & Rose, sp. nov.

Stems 6 to 7 dm. high, rather slender and more or less branched, more or less hispid; leaves much divided; rachis pilose; leaflets small, peltate, more or less roughened on both sides, paler and strongly veined beneath; akenes turgid, somewhat roughened, less than 4 mm. long. In the National Herbarium we have two specimens of this species, both from Guatemala and both distributed as *T. peltatum* One of these is No. 164, Enrique Th. Heyde, collected in 1892, and the other is Capt. J. D. Smith's No. 794, collected by Rosalio Gómez.

To this species is to be referred probably Lecoyer's *T. peltatum* from Costa Rica.

aa. *Leaflets not peltate.*

This section of Thalictrum contains about 12 Mexican species. As several species heretofore reported from Mexico must probably be excluded from its flora, and as I am in doubt as to the best treatment of some of the older species, it seems best to defer for another paper a synopsis of these species. The following new species may be described here:

Thalictrum pachucense Rose, sp. nov.

Small delicate plants with long fibrous roots, 2 to 3 dm. high, glabrous throughout; leaves all or mostly basal, small, 1 dm. or less long including the petioles, 3-ternate; leaflets small, 5 to 7 mm. long, either broad and cordate or narrow and cuneate at base, pale beneath, glabrous on both sides; pedicels erect in flower, bent at tip in fruit; flower hermaphrodite; sepals purplish; stamens apiculate; stigmatose style long and slender; immature fruit glabrous, oblong.

Collected by Mr. C. G. Pringle in open woods of the Sierra de Pachuca, Hidalgo, altitude 2,700 meters, July 16, 1898 (No. 6880).

Thalictrum madrense Rose, sp. nov.

Glabrous, slender, 1 foot or less high from a cluster of thickened roots; leaves small, sessile, 1 or 2 ternate; leaflets mostly 3-toothed or lobed; flowers diœcious(?); fertile flowers often axillary and single; style wanting; stigma short and thickened; akenes with strong undulate ribs.

Collected by J. N. Rose near the top of the west range of the Sierra Madre east of Santa Teresa in the Territorio de Tepic, August 13, 1897 (No. 2232), and on the west side of the east range in the State of Durango, August 15 (No. 3505).

This species is a near relative of *T. pinnatum*, but differs especially in having ternate instead of pinnate leaves.

Thalictrum grandiflorum Rose, nom. nov. *T. grandifolium* Rose, Contr. Nat. Herb. 5: 143. 1897. Not Watson.

This species has been distributed as *T. grandiflorum*, which name it may now bear, since the name *T. grandifolium* is a homonym.

The type (Type No. 1513) is in the National Herbarium.

Thalictrum papillosum Rose, sp. nov.

Stems low, somewhat hairy; leaves small, 3-ternate; rachis somewhat hairy; leaflets nearly round, mostly cordate at base, somewhat 3-lobed, papillose above, strongly nerved beneath and more or less hairy; inflorescence contracted; pedicels strongly nodding in fruit; akenes 2 mm. long, hardly longer than broad, with a few irregular ribs.

Collected by J. N. Rose on the road between Huejuquilla and Mesquitec, Jalisco, August 25, 1897 (No. 2586), and near Monte Escobedo, Zacatecas, August 27, 1897 (No. 2658).

This species is near *T. lanatum*, but with much shorter fruit, etc.

CEDRELA OR SPANISH CEDAR.

There is more or less confusion in the public mind regarding the Spanish cedar. It is not a coniferous tree, as is sometimes stated, but belongs to the order Meliaceae and the genus Cedrela. I have had specimens of a Cedrela from the west coast of Mexico under consideration for seven or eight years without being able to place it satisfactorily in any described species. I saw and collected specimens myself in 1897, and after my return went over the material again, concluding that it was an undescribed species. I then sent material to M. de Candolle, who agrees with me and joins in describing as below.

Mr. E. W. Nelson, who has seen much of the Spanish cedar of western Mexico, tells me that it is a common tree on parts of the coast plains from Banderas Bay to Acaponeta, in the Territory of Tepic. It is also very common on the two larger of the Tres Marias Islands, and has long been the principal source of income for these islands, the wood having been cut and exported from them, at least since 1865. Although the readily accessible supply is now nearly exhausted, yet Mr. Nelson tells me that he saw trees 24 meters (80 feet) high and with trunks 6 to 9 dm. (2 and 3 feet) in diameter. During the dry season schooners are loaded with the wood and carry it to San Francisco, where it is manufactured into cigar boxes. On the mainland I found that the wood was used by the Mexicans also for tables, doors, store fittings, furniture, clothes chests, etc. The tree is planted in many of the towns, especially along the streets and in yards, and is frequently seen along the roadside. I have seen herbarium specimens from Tepic (Palmer, 1891, 1892); San Blas and Rosa Morada (Nelson, 1897), and Acaponeta (Rose, 1897). The species is found below 1,000 feet altitude in the arid tropical zone.

A second species is here described also, coming from north of Oaxaca City. This species has heretofore been associated with *C. montana*, from which, however, it must be quite distinct. This is a small tree and is found at an altitude of 1,860 meters.

From the east coast also a considerable quantity of "cedar" is shipped to the United States. During the fiscal year of 1897-98, about $150,000 worth of the wood was shipped to the United States, the ports of shipment being Tampico, Tuxpan, Vera Cruz, Coatzacoalcos, and Frontera;

the most coming from Tuxpan. I have seen no specimens of this species. Mr. E. W. Nelson, who is familiar with the tree and its distribution, tells me that it comes from the humid tropics and is likely to be distinct from either of the above and from the Yucatan species (*C. odorata*). It is not unlikely that this species may be the little known *C. angustifolia* or the very doubtful *C. mexicana.* M. C. de Candolle writes me that *C. mexicana* can not be determined from the description. The type locality, however, is known, and by this the species may yet be made out.

The North American species may be noted as follows:

Cedrela occidentalis C. DC. & Rose, sp. nov.

Tree 15 to 20 meters high; the trunk 6 dm. in diameter; leaves rather variable, 2 to 8 dm. long; leaflets 6 to 20 pairs, variable, oblong and obtuse to lanceolate and shortly acuminate (acumen either acute or obtuse), base unequal and acute on shorter side, rounded or subacute on the other side, 5 to 18 cm. long by 2.5 to 7 cm. broad, glabrous above, at first pubescent (as is also the rachis), beneath becoming glabrate; inflorescence a broad open panicle often 4 dm. long, glabrous; pedicels very short; calyx 2 mm. long, 5-toothed; teeth broadly ovate, subacute, as long as the tube, glabrous or nearly so; petals 6 mm. long, obtuse, whitish-pubescent without; stamens glabrous, anthers not apiculate at top; column 2 to 3 mm. long, longer than the ovary; style shorter than the (glabrous) ovary; capsule 25 to 30 mm. long.

Collected by J. N. Rose at Acaponeta, June, 1897 (No. 1438); by Dr. E. Palmer at Tepic, 1891–92 (No. 1894); and by E. W. Nelson at San Blas, 1897 (No. 4343), and Rosa Morada, 1897 (No. 4357)—all in the Territorio de Tepic.

Cedrela oaxacensis C. DC. & Rose, sp. nov. *Cedrela montana mexicana* C. DC. Monogr. Phan. 1: 741. 1878.

A small tree; leaflets 6 to 7 pairs, opposite, very shortly petiolate, oblong, 5 to 12 cm. long, 3 to 4.5 cm. broad, truncate at base, shortly acuminate and obtuse, nearly glabrous above, softly pubescent beneath; inflorescence a broad terminal panicle, much longer than the leaves, glabrous; calyx glabrous, or nearly so, 5-toothed; sepals obtuse; petals 4 mm. long, reddish pubescent above, grayish below; column rather short; style short.

This species is distinct from *C. montana,* which comes from Venezuela. According to De Candolle it was collected first near Oaxaca by Andrieux, and more recently near the same locality by C. G. Pringle, August 15, 1894 (No. 4802), Lucius C. Smith, July 20, 1899 (No. 79), and J. N. Rose, June 17, 1899 (No. 4604).

The following key to the North American species may serve to distinguish the species until fuller collections may warrant a recasting of the descriptions:

KEY TO THE NORTH AMERICAN SPECIES OF CEDRELA.

a. *Leaves oddly pinnate.*

Cedrela imparipinnata C. DC. (Guatemalan species.)

aa. *Leaves not oddly pinnate.*

b. *Mature leaves glabrous on both sides.*

c. *Calyx glabrous, or nearly so; sepals acute.*

d. *Style as long as the petals; acumen of the leaf elongated, acute.*

Cedrela odorata L. fide C. DC. (Yucatan plants.)

dd. *Style shorter than the petals; acumen of the leaf short and obtusish.*

Cedrela occidentalis C. DC. & Rose. (Rose's No. 1438.)

cc. *Calyx puberulent; sepals obtuse.*

Cedrela angustifolia DC. } doubtful species.
Cedrela mexicana Roem. }

bb. *Mature leaves pubescent beneath.*

e. *Petals grayish pubescent.*

Cedrela fissilis Vell. (Guatemalan.)

ee. *Petals reddish pubescent.*

Cedrela oaxacensis C. DC. & Rose. (*C. montana mexicana* C. DC.)

NOTES ON NEW OR RARE LEGUMINOSAE.

AESCHYNOMENE.

Specimens of several species of Aeschynomene have recently been added to the National Herbarium. After a most careful study of the genus I am convinced that 5 of the species are undescribed. The added material is as follows:

Aeschynomene acapulcensis sp. nov.

Prostrate herbs with long slender wiry branches, slightly pubescent but never glandular or viscid; stipules broadly ovate, acute, persistent even after the leaves have fallen; leaflets 5 to 7, glabrous, obovate to oblong, rounded at apex, 8 to 12 mm. long; calyx 2 mm. long, slightly longer than the subtending bracts; corolla yellow, 6 mm. long; stipe long (4 to 5 mm.); ovary glabrous; legume deeply notched on the back, 2-jointed (in my specimen). Collected by Dr. E. Palmer near Acapulco, Mexico, in 1894–95 (No. 126). This species much resembles *A. viscidula*, but is of very different habit and foliage.

Hemsley in the Biologia gives a species from Acapulco, but without specific name. This may be the plant.

Aeschynomene amorphoides (Wats.) Rose.

A shrub 12 dm. high.

Very common about Bolaños, Jalisco, September 10 to 19, 1897 (No. 2859).

Aeschynomene compacta Rose, sp. nov.

Apparently a very compact shrub 9 to 30 dm. high; old branches smooth and gray; young branches very silky; leaflets numerous (15 to 25 pairs), crowded, 3 to 4 mm. long, somewhat 3-nerved, the main nerve submarginal, acute, more or less appressed-pubescent; petiole very short; stipules linear; inflorescence compact, shorter than the leaves, few-flowered, pedicels short; bractlets 2, orbicular, obtuse, 3 to 4 mm. long, about the length of the calyx tube, silky-pubescent; calyx slightly 2-lipped, the 2 upper teeth slightly united, obtuse, the 3 lower teeth ovate, acute, the middle one longer; corolla "maroon-red," banner orbicular with short broad claw; fruit short-stipitate (3 to 4 mm. long), 2-jointed (in my specimens), deeply constricted between the joints, especially indented on the dorsal side, covered with short appressed hairs.

Collected by Mr. C. G. Pringle, in Tomellin Canyon, State of Oaxaca, October 1, 1894 (No. 5645); by E. W. Nelson between Juchitan and Chivela, Oaxaca, 1895 (No. 2630), and by Lucius C. Smith, June 1, 1895 (No. 452).

This species resembles *A. fascicularis* in foliage, but is of more compact habit, and has smaller leaflets, a different calyx and different bractlets. *A. fascicularis* has short, acute bractlets, the sepals are all acute, the corolla also larger, and its petals longer-clawed.

Aeschynomene fascicularis Schlecht. & Cham. Linnæa, **5**: 584. 1830.

Flowers yellow.

Collected by J. N. Rose near San Juan Capistrano, August 22, 1897 (No. 2482), and west of Bolaños, September 10 to 19 (No. 2937).

Aeschynomene fruticosa Rose, sp. nov.

A shrub 12 to 15 dm. high, with stiff grayish branches; young parts strigose-pubescent, becoming glabrous; leaves small; leaflets 3 or 4 pairs, oblong, 8 to 14 mm. long, rounded at base, also at apex, long-apiculate, nearly glabrous; flowers fascicled in the axils or in a short few-flowered raceme shorter than the leaves; pedicels slender, 10 to 12 mm. long; buds long-acuminate; the 2 bracts subtending the flowers small, much shorter than the calyx, 2 mm. long, ovate, acute, striate; calyx tube 2 mm. long, slightly hairy; sepals 5, the 2 upper ones 3 mm. long, acute, united to the middle; the 3 lower lobes unequal, the central one long-acuminate, 4 mm. long, the other two 2 mm. long, acute; corolla yellow, 6 mm. long, somewhat pubescent without; stamens of the genus; ovary pubescent; stipe not longer than the longest sepal, sometimes not longer than the calyx tube; legume with face nearly straight, deeply indented on the dorsal side, 1 to 3 jointed, becoming glabrate in age.

Collected by Dr. E. Palmer on stony hills near Topolobampo, State of Sinaloa, September 15 to 25, 1897 (No. 204). Near *A. palmeri*, but with smaller leaflets, very different calyx, etc.

Aeschynomene palmeri Rose, sp. nov.

A shrub with grayish bark thickly set with small lenticels; young branches slightly pubescent, soon glabrate; leaflets 4 to 7 pairs, orbicular to oblong, glabrous or nearly so, 10 to 25 mm. long, rounded at base, but usually somewhat oblique, obtuse, rounded or retuse, and apiculate at apex, dark green and shining above, paler beneath; inflorescence paniculate or simply racemose; pedicels slender; bracts 2, ovate, acute, striate; calyx small, the 4 upper lobes about equal, nearly orbicular, rounded at apex; the lower lobe longer, narrower, and acuminate, all a little hairy on the margin; corolla rose-colored (?); banner large, orbicular, strongly bent backward; wings and keel deeply auricled (on one side) and slender-clawed: keel strongly inflexed; stamens (as of the genus) in 2 clusters of 5 each; ovary glabrous, stipitate; style very long and filiform; mature joints obliquely obovate, glabrous and shining; immature pod 3-lobed.

Collected by Dr. E. Palmer near Acapulco in 1894–95 (No. 106*a*).

A very distinct species.

Aeschynomene paniculata Willd.; Vog. Linnæa, **12**: 95. 1838.

Collected by Dr. E. Palmer near Acapulco in 1894–95 (No. 283).

This species has once before been reported from Mexico, but without definite locality.

Aeschynomene petraea Robinson, Proc. Am. Acad. **27**: 166. 1892.

Collected by E. W. Nelson on mountains near Talpa, altitude 4,400 to 5,000 feet, March 7, 1897 (No. 4033); on roadside between Mascota and San Sebastian, Tepic, March 14, 1897 (No. 4058); and by Mr. E. A. Goldman near Chacala, Durango, February 23, 1899 (No. 329).

Aeschynomene simulans Rose, sp. nov.

Perennial; stems herbaceous, about 3 dm. high, branching at the base, nearly glabrous throughout; leaflets 8 to 12 pairs, oblong to oval, rounded or cordate at base, more or less oblique, rounded or retuse and shortly mucronate at apex, 8 to 18 mm. long, thickish, strongly nerved, nearly glabrous; stipules ovate, acute; flowering stems often leafless, forming a branching panicle, or the flowers borne in axillary racemes shorter than the leaves; inflorescence but slightly pubescent, never glandular; pedicels very short, of fruit sometimes 6 mm. long; bracts ovate, obtuse, 1 mm. long; calyx glabrous; 4 upper sepals obtuse; lower sepal acute; corolla yellow, tinged with purple, 8 mm. long; legume stipitate, 3-jointed, constricted on both sides, but most on the dorsal side, nearly glabrate.

Collected at Acaponeta, June 26, 1897 (No. 1487), and between Rosario and Colomas, July 12, 1897 (No. 1616).

This species is near, perhaps too near, *A. petraea* Robinson, but differs in coming from the low, hot coastal plain of the west coast, while *A. petraea* comes from much higher elevations; it also has very different pubescence, larger leaflets, smaller bracts and flowers, glabrous calyx, etc.

CALLIANDRA.

Mexico and Central America contain about 35 species of Calliandra, all but 5 of which are represented in the National Herbarium. Bentham, in his monograph of the genus, enumerates just 100 species, of which he assigns 25 to North America. Mr. Hemsley, in the Biologia Centrali-Americana, lists 23 species.

I have decided to publish the four following species only after a very careful study of all the Mexican members of the genus. It was my intention to publish here a synopsis of all our Mexican species, but owing to the difficulty in deciding the identity of 2 or 3 of them, I have postponed this revision to a future paper.

Series LAETEVIRENTES.

Calliandra oaxacana Rose, sp. nov.

Nine to 15 dm. high; branches slender and glabrous; pinnæ 1 to 2 pairs; stipules 2 mm. long, obtuse; petiole without glands, 2.5 to 3.5 cm. long, slender; leaflets 14 to 18 pairs, oblong, acute, 5 to 6 mm. long, glabrous except a few hairs along the margin (and also on the secondary rachis); heads 1 to 3 in the axils of the leaves; peduncles slender, 5 to 7 cm. long, longer than the leaves; stamens 18 to 20 mm. long, reddish; pods unknown.

Collected by Mr. C. G. Pringle, July 10, 1897, on granite ledges, Tomellin Canyon, Oaxaca, altitude 1,050 meters (No. 6734).

Calliandra penduliflora Rose, sp. nov.

A shrub, 3 meters or so high, with light gray bark; young branches covered with short spreading pubescence; leaves large; pinnæ 1 or 2 pairs; leaflets 4 to 6 pairs, unequal, the largest ones 4 to 5 cm. long, oblong, rounded at apex, very oblique at base, 3 to 5 nerved at base, pubescent on both sides; stipules variable, 6 to 10 mm. long, striate; inflorescence axillary or more or less naked and paniculate above; peduncles often 2 to 4 in the axils, long and slender, sometimes 1 dm. long; heads large and densely flowered; calyx and corolla glabrous; stamens long and pendent; fruit not seen.

Collected by J. N. Rose in southern Durango, August 16, 1897 (No. 2332), and at Bolaños, September 14 (No. 2924). The latter collection is the type of the species.

This is a very beautiful plant, and not closely related to any other of the Mexican species.

Calliandra unijuga Rose, sp. nov.

Shrub 12 to 24 dm. high, with many short stiff grayish branches; leaves small; petioles 2 to 4 mm. long; pinnæ 1 pair; leaflets 2 to 4 pairs, leaflets oblong, 2 to 4 mm. long, nearly glabrous, obtuse, sometimes apiculate; peduncles axillary, 15 to 20 mm. long; stamens long, white with pink tips; legume 3.5 cm. long, glabrous.

Collected by Lucius C. Smith at Cuicatlan, State of Oaxaca, altitude 1,800 feet, September 24, 1894 (No. 203), and by Mr. E. W. Nelson at the same locality, October 8 to 24, 1894 (No. 1648).

Series MACROPHYLLAE.

Calliandra laevis Rose, sp. nov.

A tree, 7.5 meters or more high, glabrous throughout; pinnæ 1 pair; leaflets 1 pair, 5 to 10 cm. long, lanceolate, midrib somewhat one-sided; peduncle 2.5 to 3.5 cm. long; calyx 2 mm. long; corolla elongated, 6 to 8 mm. long; stamens 3.5 cm. long; pods 10 to 13 cm. long.

Apparently common along the upper edges of the Tropics. Collected by J. N. Rose near Colomas, State of Sinaloa, July 18, 1897 (No. 1753), and at Dolores, Territorio de Tepic, August 6, 1897 (No. 3365).

Near *C. emarginata*, but leaflets always in one pair and not 3-nerved.

MISCELLANEOUS SPECIES.

Acacia subangulata Rose, sp. nov.

A spreading shrub, 5 to 7 m. high; branches somewhat angled, bearing short straight prickles, more or less puberulent; stipules small, somewhat membranaceous, 2 to 4 mm. long; petiole short (13 mm. long), bearing a large but inconspicuous and depressed oblong gland near the middle; main rachis somewhat 4-angled, sometimes prickly; pinnæ about 7 pairs; stipels minute; leaflets 20 to 30 pairs, oblong, 5 to 7 mm. long, midnerve strongly eccentric, thickish, puberulent; inflorescence a large spreading naked panicle; heads more or less verticillate, on peduncles less than one inch long; stamens numerous, pale yellow; legume unknown.

Collected by Mr. C. G. Pringle on calcareous hills near Tehuacan in the eastern part of the State of Puebla, August 6, 1897 (No. 6775).

This Acacia comes nearest *A. berlandieri*, but has fewer pinnæ and leaflets, the latter larger, thicker, and greener, etc.

Brongniartia lunata Rose, sp. nov.

A low shrub; branches slender, pubescent; leaves 1.5 to 2 dm. long; stipules lunate-reniform, but the upper lobe acute; leaflets distant, 3 to 5 pairs, oblong, 48 to 55 mm. long, rounded and apiculate, above pubescent, becoming glabrate in age, beneath paler, appressed-pubescent, and in age reticulated; flowers in pairs in the axils; peduncle 2.5 mm. long, glabrous; subtending bracts not seen; calyx 15 mm. long, glabrous without; corolla 25 mm. long; legume not seen.

Collected by J. N. Rose in the State of Durango, east of Huasemote, August 15, 1897 (No. 2314). Very different from the above and all other species which I have seen in the shape of its stipules.

Brongniartia diffusa Rose, sp. nov.

Low, diffuse shrub, about 1 dm. high, glabrous or nearly so throughout; stipules oblong to ovate, 6 to 8 mm. long, acute, deciduous; leaflets 3 to 9 pairs, oblong, 12 to 20 mm. long, rounded or slightly cordate at base, rounded or retuse at apex, apiculate, glabrous; flowers 1 to 2 in the axils; peduncles 25 to 35 mm. long, slender; bracts subtending the flowers broadly ovate, 8 mm. long, scarious, caducous; calyx 8 mm. long, the lobes acute, the 2 upper lobes united to near the top, glabrous without, pubescent within; corolla 18 mm. long, purplish; ovary glabrous, stipitate, 3-ovuled; immature pods, 35 mm. long, 12 mm. broad.

Collected by J. N. Rose between Pedro Paulo and San Blascito, August 4, 1897 (No. 1978).

This species is very distinct from any other species of this genus which I have seen.

Cassia pringlei Rose, sp. nov.

Shrub 2.5 to 4 m. high; young branches somewhat pubescent, but soon becoming glabrate; leaves 2.5 cm. long, without glands; stipules wanting; leaflets 2 or 3 pairs, becoming glabrate in age, mostly oblong, sometimes orbicular or obovate, somewhat oblique at base, rounded at apex, sometimes apiculate; inflorescence and flowers similar to the above; legumes 1.8 to 2.3 dm. long, 6 mm. wide.

Collected by Mr. C. G. Pringle, at Tomellin Station, State of Oaxaca, altitude 615 meters, July 14, 1897 (No. 7478); and by Mr. E. W. Nelson between Petlatcingo and Acatlan, State of Puebla, November 20, 1894 (No. 1996).

This species is near *C. wislizeni* Gray, but abundantly distinct. (Only 4 or 5 specimens taken while the train stopped for dinner.)

Cassia unijuga Rose, sp. nov.

Small shrub, 3 to 6 dm. high; leaves without glands; young branches densely villous; stipules filiform, 4 to 6 mm. long; petiole very short or wanting; leaflets 1 pair, rarely 2 pairs, nearly orbicular, rounded or somewhat cuneate at base, rounded and apiculate at the summit, about 12 mm. in diameter, more or less villous, but becoming glabrous; flowers large, in few-flowered axillary racemes; sepals large and obtuse; corolla 2.5 cm. or more in diameter; perfect stamens 7, abortive 3; legume flat, 1 to 1.3 dm. long, 6 mm. wide, acuminate, stipitate.

Collected by Mr. C. G. Pringle in the eastern part of the State of Puebla, near Tehuacan, August 5, 1897 (No. 6773).

This species comes nearest our United States species, *C. wislizeni*, differing especially in its leaflets. It has no close affinities with any of the other described Mexican species except *C. pringlei* above.

Pithecolobium acatlense Benth. Trans. Linn. Soc. **30**: 593. 1875.

This species is very common in the tropical valleys of western Mexico. It is a shrub growing to the height of 3 to 5 meters, the corolla is covered with long silky hairs and the stamens are long-exserted as in Calliandra. The pod, which has never been described, is 15 cm. long and 2 cm. wide, much flattened, tapering at base into a stipe and apiculate at tip, densely covered with short reddish hairs.

Collected by J. N. Rose in southern Durango between the two ranges of the Sierra Madre, August 14, 1897 (No. 2270); near San Juan Capistrano, Zacatecas, August 19 (No. 2434); near Huejuquilla, Jalisco, August 25 (No. 3564), and at Bolaños, September 10 to 19 (No. 3692).

DESCRIPTIONS OF MISCELLANEOUS NEW OR RARE SPECIES.

Ayenia fruticosa Rose, sp. nov.

Low shrub; young branches densely stellate-pubescent; sepals small, 2 to 3 mm. long, ovate, acuminate; petioles short, 2 to 4 mm. long; blade ovate, acute or obtuse, 8 to 15 mm. long, stellate-pubescent on both sides, paler beneath; flowers solitary and axillary; pedicels slender, long (much longer than the subtending leaf) 20 to 30 mm. long, bracteate some distance below the middle; sepals ovate, shortly acuminate, 2.5 mm. long; stamens 5; anthers 3-celled; ovary sessile; fruit densely covered with long (for the genus) prickles.

Collected by Mr. C. G. Pringle near Tehuacan, State of Puebla, altitude 1,500 meters, 1897 (No. 6743).

Celastrus pringlei Rose, sp. nov.

A vine climbing to 6 meters, the branches reddish, thickly dotted with small whitish lenticels; leaves alternate, narrowly elliptical, rounded or wedge-shaped at base, acute, 7.5 to 10 cm. long, 1.8 to 2.5 cm. broad at the middle, with shallow, obtuse teeth, usually apiculate, dark green, glabrous; racemes 1 to 3 in an axil, 2.5 to 5 cm. long; pedicels 4 to 6 mm. long, 2 or 3 bracted, jointed just below the flower; sepals 5; petals 5, white; stamens 5, filaments attached below the disk; anthers broadly ovate, apiculate; disk prominent, lobed; ovary 3-celled; cells each with one erect ovule; dehiscence of capsule loculicidal; seeds covered with a yellow aril.

Collected by Mr. C. G. Pringle in canyons of mountain side above Cuernavaca, altitude 2,300 meters, June 1, 1898 (No. 6842).

Cleome humilis Rose, sp. nov.

Annual, erect, slender, simple or somewhat branching, 10 to 30 cm. high, glabrous except a little scabrosity on stem, petioles, and blade; leaflets 3, linear-lanceolate, acute, 6 to 30 mm. long, longer than the petioles; racemes loose, few-flowered; pedicels 6 to 8 mm. long; petals yellow, 3 to 4 mm. long; pods sessile, narrow, spreading, 30 mm. long.

Found in the tropical valleys of the table-land. Collected by J. N. Rose near San Juan Capistrano, August 22, 1897 (No. 2429), and at Bolaños, September 10 to 19 (No. 2900). This species is very similar to *C. tenuis* Watson, but of different range and with 3 instead of 5 leaflets, etc.

Couepia polyandra (H. B. K.) Rose. *Hirtella polyandra* H. B. K. Nov. Gen. et Sp. 6: 246, *t. 565.* 1823. *Moquilea kunthiana* Mart. & Zucc. Abh. Akad. Muench. 1: 390. 1830. *Couepia kunthiana* Benth. Hook. Journ. Bot. 2: 216. 1840.

This species was collected by Humboldt and Bonpland near Acapulco, and was named and described by Kunth as a Hirtella, the fruit being then unknown. Mr. Hemsley also refers to this species a plant collected by Linden in Tabasco. These are the only published records of the collection of this species. We have no authentically named specimens in the National Herbarium. The species has recently been re-collected at the type locality by Dr. E. Palmer, also only in flower. I collected the specimens at several places about Acaponeta, where it is certainly native and is well known under the name of zapote. At Acapulco, Dr. Palmer states that it is called zapote amarillo. The fruit is apparently eaten, but I saw none in the markets. The fruit is oblong, about 3 inches long, of yellow color and with a somewhat roughened or warty skin. It contains one large seed which is attached at the base. We now have the following specimens in the National Herbarium:

Dr. E. Palmer's No. 401 (1894–95) from Acapulco.

J. N. Rose's Nos. 1515, 3120, 3310 (1897) from near Acaponeta.

Cuphea trichopetala Rose, sp. nov. PLATE XXII.

Stems weak, shrubby at base; branches glabrous, leaves usually much longer than the internodes, lanceolate or oblanceolate, 5 to 14 cm. long, acute, sometimes slightly acuminate, sessile or tapering into a broadly winged petiole more or less auriculate at base, nearly smooth except on the veins; inflorescence short, terminal, few-flowered; calyx greenish, 16 mm. long, strongly spurred, glabrous within, more or less setose without, the upper sepal slightly larger than the 5 lower; the appendages alternating with, and shorter than the sepals, each 3 to 6 setose; two dorsal petals showy, red, 7 mm. long, orbicular and rounded at apex, tapering at base into a slender claw; the 4 ventral petals reduced to long hairs, 11 mm. long, purplish at tip; stamens 11, equally inserted and all glabrous, two dorsal included; 9 exserted, unequal, 5 longer; style and ovary glabrous; seeds 10; gland large, reflexed.

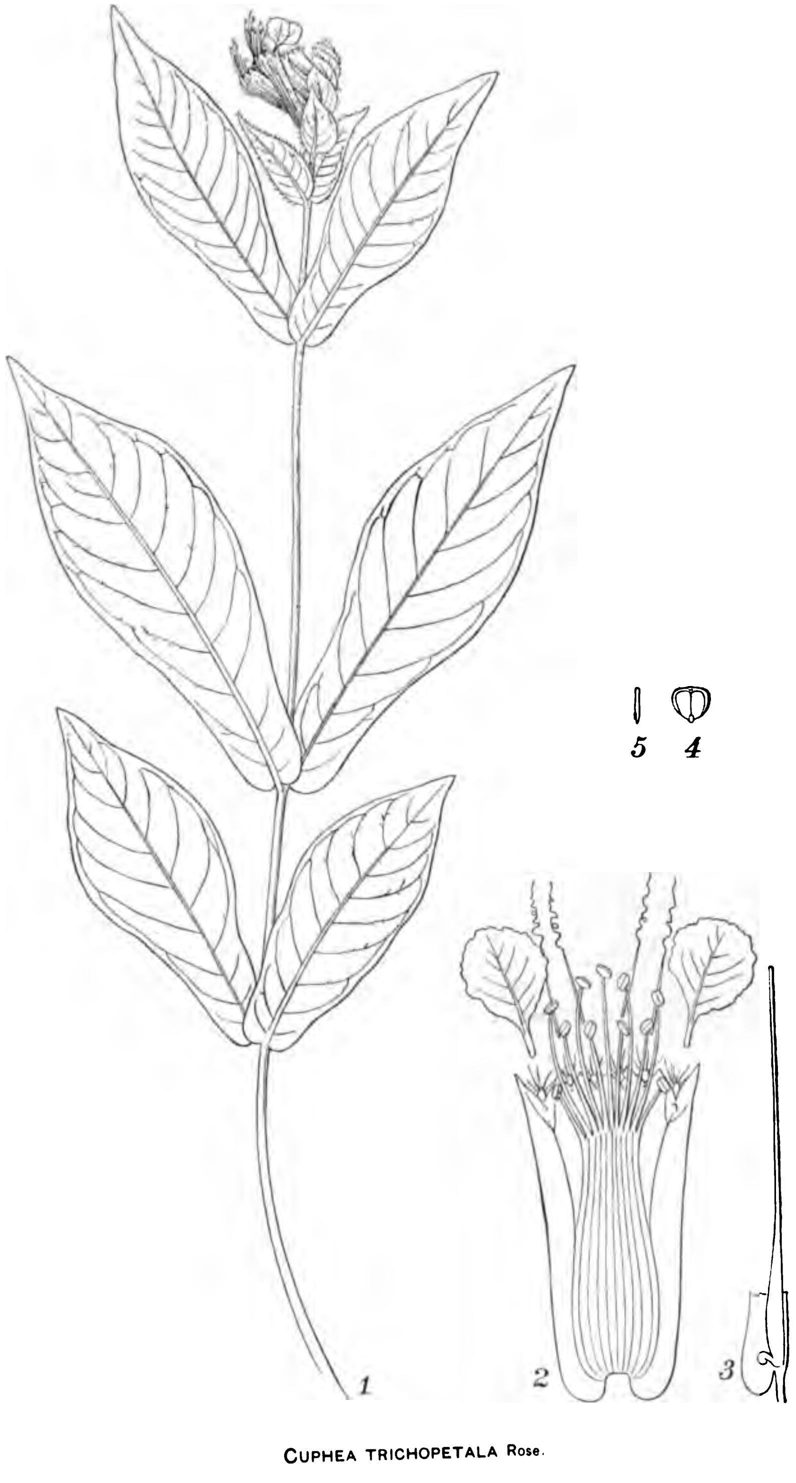
Collected by J. N. Rose in a deep canyon just below Colomas, Sinaloa, altitude 2,000 feet, July 20, 1897 (No. 1769).

This species is near the next and *C. graciliflora*, but differs in its leaves, petals, etc. It is especially remarkable in having the four ventral petals reduced to long hairs, which curl up at the tip much like a tendril.

EXPLANATION OF PLATE.—Fig. 1, the upper part of the plant; fig. 2, flower with the calyx split open and the 6 petals detached; fig. 3, the ovary and glands; figs. 4 and 5, face and side views of the seed. Fig. 1, natural size; figs. 2 and 3, scale of 3.

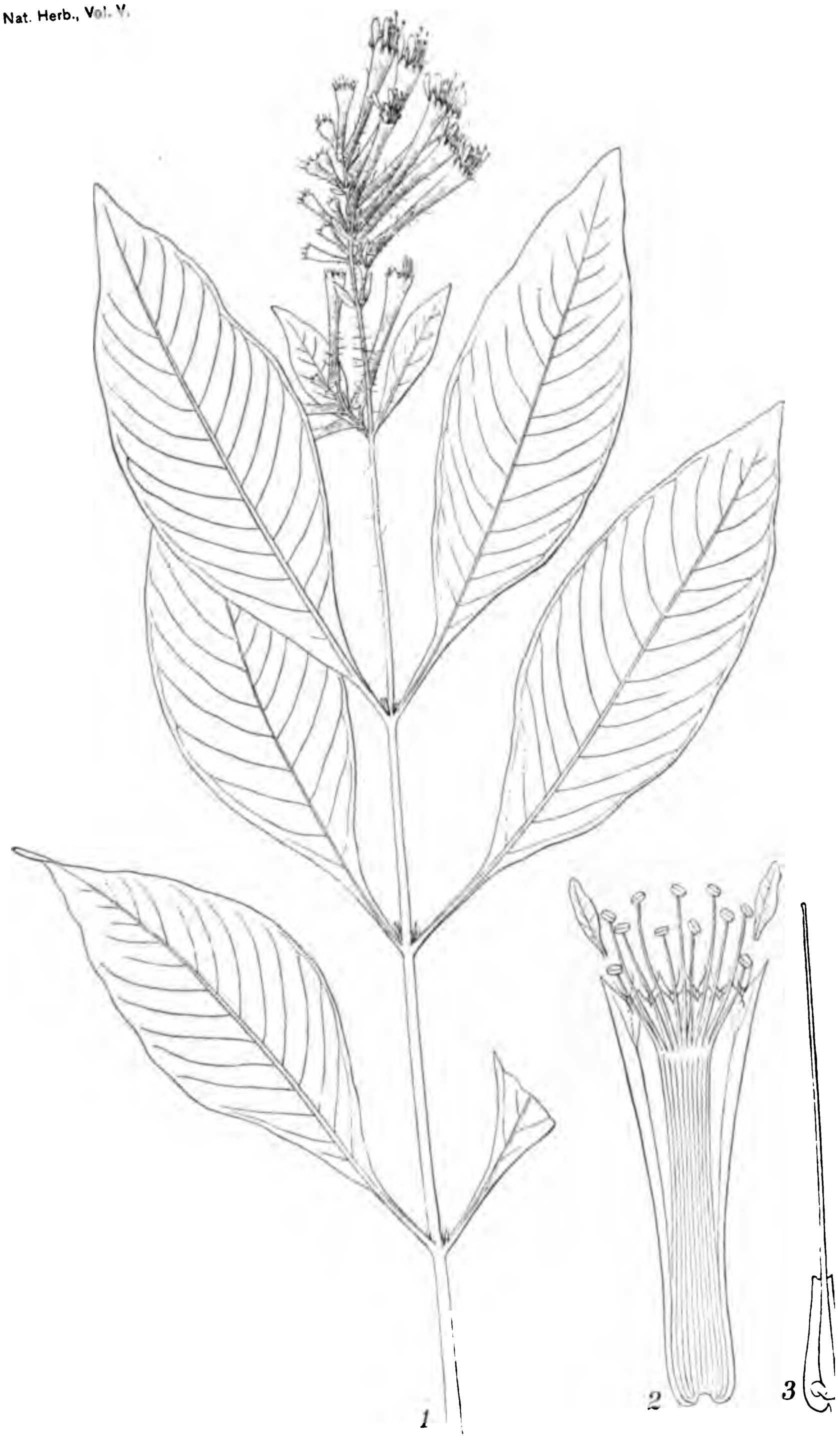
Cuphea cristata Rose, sp. nov. PLATE XXIII.

Plant more or less shrubby at base; branches with minute appressed pubescence, the internodes either short or elongated; leaves lanceolate, 7.5 to 12 cm. long, 25 to 40 mm. broad, tapering at base into a short petiole, slightly roughened above, paler beneath, mid-nerve and lateral veins somewhat prominent; inflorescence (in my specimens) a short, dense, terminal leafless raceme; pedicels short; prophylla ovate, deciduous; calyx slender, 28 to 30 mm. long, narrowly funnel-formed, glabrous

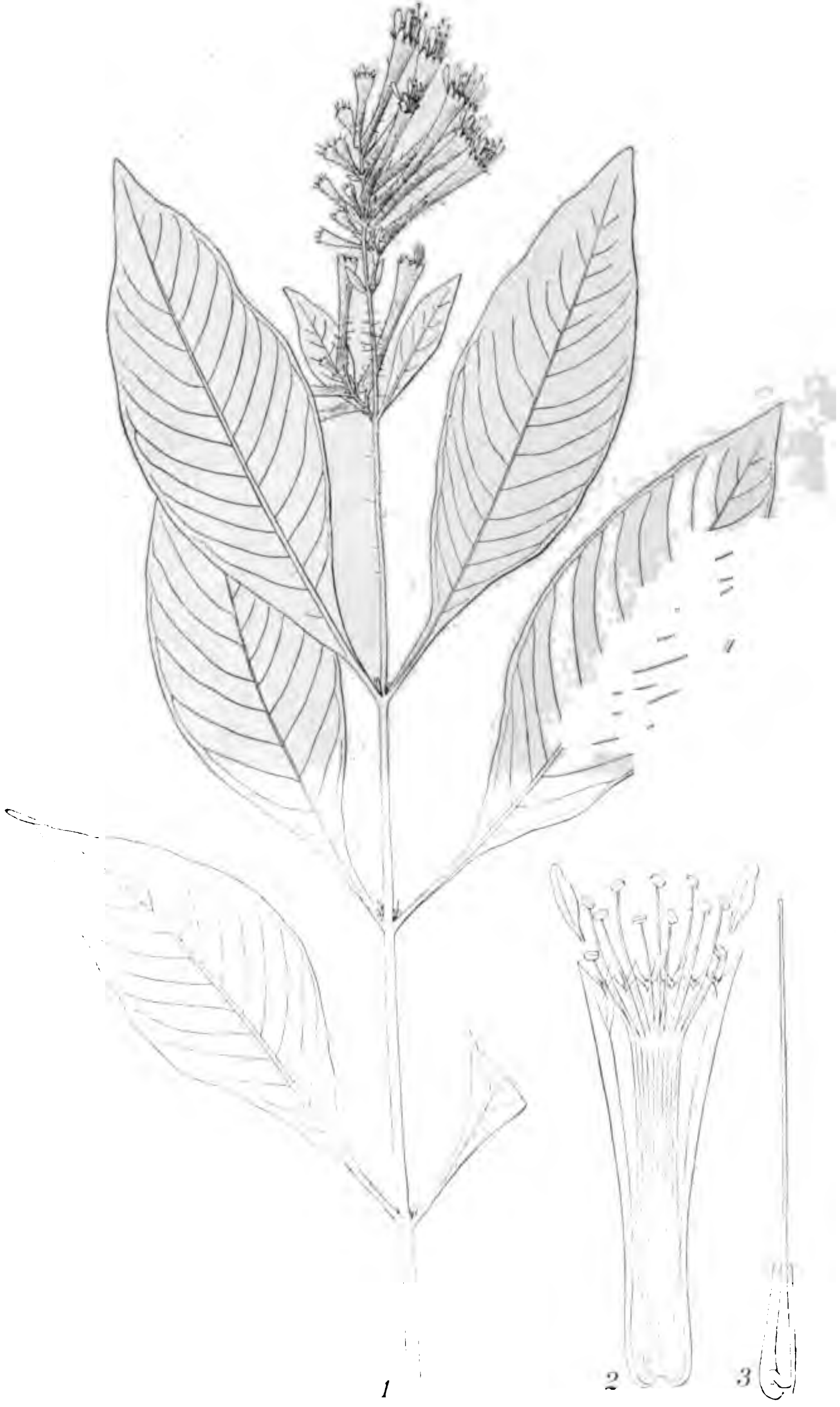


CUPHEA TRICHOPETALA Rose.

PLATE XXIII.



CUPHEA CRISTATA Rose.



CUPHEA CRISTATA R

within, sparingly setose and with short appressed pubescence without, reddish or bluish above, greenish below, somewhat gibbous at base, the upper sepal slightly larger than the 5 lower; the appendages alternating with the sepals, only half their length, and bearing long setæ as long as the sepals; petals 2, dorsal, narrowly oblong, apiculate, red, 6 mm. long, each subtended by a small flat squamula below the sinus; stamens 11, equally inserted and all glabrous; two dorsal much shorter; the other 9 much exserted, the 5 opposite the sepals longer than the 4 alternating with them; style and ovary glabrous; ovules 9; gland reflexed.

Collected by J. N. Rose in the foothills between Acaponeta and Pedro Paulo, Jalisco, August 2, 1897 (No. 1917), and between Pedro Paulo and San Blascito, Tepic, August 4 (No. 3341).

This species is nearest *C. graciliflora* but quite different.

The specific name is suggested by the crest of hairs which crowns the flower buds.

EXPLANATION OF PLATE.—Fig. 1, a flowering branch; fig. 2, flower with the calyx split open and the petals detached; fig. 3, style and gland. Fig. 1, natural size; figs. 2 and 3, scale of 3.

Cuphea koehneana Rose, sp. nov. PLATE XXIV.

Annual; stems simple, 6 to 7 dm. high, clothed with short, rather stiff pubescence; leaves opposite, broadly lanceolate, 10 to 15 cm. long, including the slender petiole (18 to 35 mm. long), somewhat oblique and tapering at base, acuminate, very thin, with scattered appressed pubescence on both sides, paler beneath, the lateral veins prominent beneath; the inflorescence terminal and paniculate; bracts long, filiform, setose; calyx slender, 18 to 20 mm. long, shortly spurred at base, somewhat enlarged at the top, two-nerved within, glabrous below; two dorsal petals 12 to 15 mm. long, 8 mm. broad, tapering into a slender claw 2 to 5 mm. long, deep purple, inserted on each side of the dorsal sepal just above the corresponding sinus; 2 ventral petals much smaller (5 mm. long); stamens 11, some of them exserted, two a little farther than the others, these densely clothed with long, purple wool; seeds about 9; disk dorsal, reflexed.

Collected by Mr. C. G. Pringle at Cuernavaca, Mexico (No. 6657).

This species belongs in Koehne's section Diploptychia, but is very distinct from the other species of the section. Perhaps nearest to *C. nudicostata* and *C. pinetorum*.

EXPLANATION OF PLATE.—Fig. 1, a flowering branch; fig. 2, a flower, showing the calyx split open and the petals detached; fig. 3, the style and gland; figs. 4 and 5, face and side views of seed. Fig. 1, natural size; all dissections scale of 3.

Gronovia longiflora Rose, sp. nov. FIGURE 30.

Leaves slightly lobed, with open sinus; flowers tubular, 20 mm. long, ovary 2 mm. long, tube 10 mm. long, sepals 2 to 3 mm. long; petals and stamens longer than the sepals, free to the base, the former 14 to 16 mm. long; fruit strongly 5-winged, the wings toothed.

Collected by C. G. Pringle on lava beds near Cuernavaca, November 3, 1896 (No. 7322).

Hippocratea pauciflora Rose, sp. nov.

Rather low woody vines; leaves opposite, obovate to spatulate-oblong, 5 to 7.5 cm. long, 16 to 28 mm. wide, rounded at apex, glabrous, pale green on both sides, crenate; petioles 4 mm. long; stipules small, lacerated; flowers not seen; fruit solitary, or in small dichotomous clusters of twos to fours; peduncles 2.5 to 3.8 cm. long, either axillary or terminal; carpels oblong, 5 to 6.5 cm. long.

Collected by J. N. Rose, near Rosario, State of Sinaloa, June 10, 1897 (No. 1587). Only a single plant of this species was seen, in a deep wooded canyon about 1 mile north of Rosario near the river.

Hippocratea utilis Rose, sp. nov.

High-climbing woody vines; leaves opposite, oblong, 7.5 to 8.5 cm. long, 3.5 to 5 cm. broad, obtuse, rounded at base, glabrous, dark green above, paler beneath, thickish, coarsely crenate (each tooth bearing a deciduous apiculation); petioles 10

mm. long; stipules linear, 2 mm. long; flowers not seen; fruit apparently borne in small panicles; carpels elliptical, oblong, 3.2 to 4.5 cm. long, less than 2.5 cm. wide, rounded at both ends.

Collected by J. N. Rose near Colomas, State of Sinaloa, in the foothills of the Sierra Madre, July 16, 1897 (No. 1706).

This is the most northern species known, all the species referred to by Hemsley in the Biologia being confined to south Mexico and Central America, 6 of the 15 being from Panama. The other species are apparently all from the Tropics, while this species is found in the edge of the Lower Sonoran area at an altitude of about 2,900 feet. This is a very important vine and much used by the people on the west coast of Mexico, where it is known as "bejuco colorado." It is used in many ways, and takes the place of ropes, wires, etc., among the plain people. It is employed in making the cactus fences to fasten the upright trunks together. In the building of their rude huts it serves to tie fast the rafters. I saw, at Palmacito, Sinaloa, a vine 18 meters long used for a clothes line. The vine is said to have great strength. A second species grows along the coast, but I was repeatedly told that the "bejuco colorado" was always obtained from the mountains.

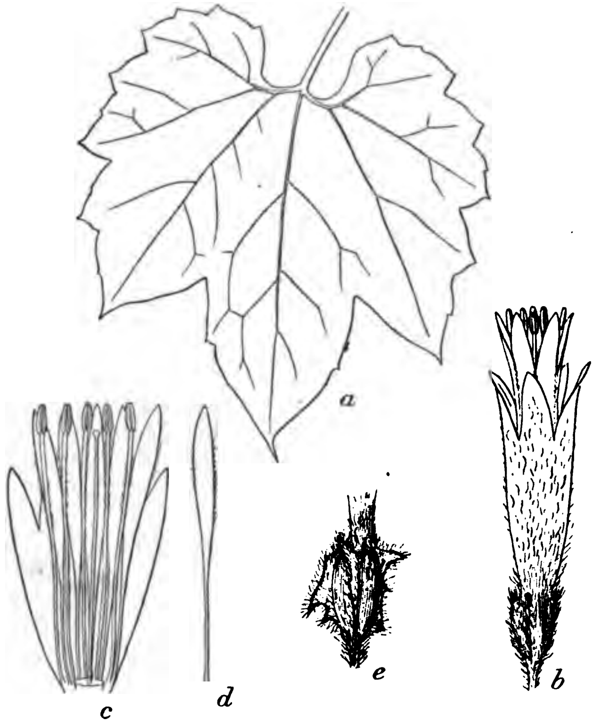
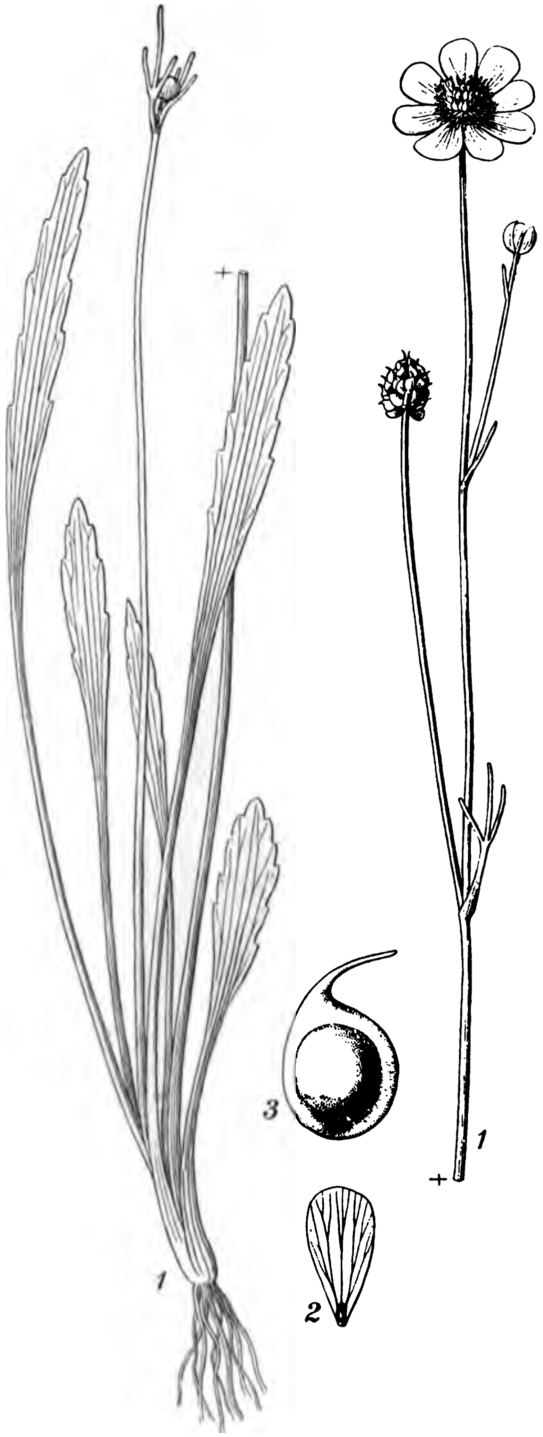


FIG. 30.—*Gronovia longiflora.* *a*, Leaf; *b*, flower; *c*, same cut open; *d*, petal; *e*, fruit. *a*, scale of $\frac{2}{3}$; *b*, *c*, *d*, *e*, scale of 2.

Nesaea pringlei Rose, sp. nov.

Perennial, diffuse, much branched at base; branches slender, procumbent or ascending, glabrous, terete or nearly so, 5 cm. to 9 dm. long; leaves opposite, linear, somewhat variable in length, 1 to 4 cm. long, usually 2 mm. or less wide, sometimes narrowly oblong and 4 mm. wide, the margins not revolute, tapering at base into very short petioles, usually much longer than the internodes, but sometimes much



RANUNCULUS MADRENSIS Rose.

shorter; flowers solitary in the axils; peduncles 2.5 cm. or more long, bibracteate near the base of the flowers; calyx campanulate, 6 mm. high, 12-nerved, 6-lobed, the lobes ovate, acute, 2 mm. long; petals 6, purple, 10 mm. long; stamens about 12, much shorter than the petals, about equal, inserted in a single row near the middle of the calyx; style elongated much longer than the stamens, nearly as long as the petals; ovary shortly stipitate, orbicular, 4-celled; the carpels apparently splitting to the very top.

Collected by Mr. C. G. Pringle on dry plains near Tehuacan, State of Puebla, August 2, 1897 (No. 6758).

This species is closely related to *N. longipes* Gray and the two may represent a new generic type.[1] The dehiscence of the capsule is uncertain in Mr. Pringle's plant, and it has also been uncertain in *N. longipes;* but Professor Coulter states in the Botany of Western Texas[2] that the capsule opens by a little lid.

Ranunculus madrensis Rose, sp. nov. PLATE XXV.

Rather slender, erect, from a cluster of somewhat thickened roots; 18 to 26 cm. high, glabrous below; basal leaves erect, long-petioled (4 to 10 cm. long); blade linear to linear-oblong, cuneate at base, obtuse at apex, with coarse distant teeth, 3 to 5 cm. long, 4 to 8 mm. wide, thickish, strongly nerved; stem leaves reduced to a few simple or 3-lobed linear bracts; stem bearing 1 to 4 small flowers; peduncle slender, 6 to 10 cm. long, hairy above, especially just under the flower; sepals purplish or yellowish, about half the length of the petals, glabrous, deciduous; petals about 10, yellow, nearly obovate, rounded at apex, 8 mm. long; receptacle hairy; akenes small (2 mm. or less long), lenticular, glabrous, tipped with a slender persistent style equal in length to the akene.

Collected by J. N. Rose on the top of the Sierra Madre between Santa Gertrudis and Santa Teresa, Territorio de Tepic, altitude about 2,000 meters, August 8, 1897 (No. 2102); and in the State of Zacatecas, altitude about 2,615 meters, August 18, 1897 (No. 2375). I found this plant common in damp grassy meadows on the flat tops of the two ranges of the Sierra Madre, and it doubtless has a wide distribution, although I have not been able to identify it with any one of the 25 Mexican or Central American species hitherto described. In fact it is not near any of the Mexican species which I have seen, but it most suggests the *R. vagans* of Watson. It is nearer, however, our Western United States species, *R. alismaefolius.*

EXPLANATION OF PLATE.—Fig. 1, a flowering plant; fig. 2, a petal; fig. 3, an akene. Fig. 1, natural size; fig. 2, scale 5; fig. 3, scale 2.

Samyda mexicana Rose, sp. nov.

Shrub 15 to 25 dm. high; branches rather short and stiff, with grayish bark, the younger ones more or less pubescent, very leafy; leaves 3 to 7 cm. long, oblong, rounded or somewhat narrowed at base, shortly acuminate and obtuse, at first softly pubescent on both sides, in age more scantily and coarsely, becoming more or less reticulated beneath, the margin bearing small distant and gland-tipped teeth, the surface covered with round or oblong pellucid dots, petioles very short; bracts of buds ovate to orbicular, pubescent; pedicels short; calyx white, pubescent; tube 8 mm. long; sepals 4 or 5, 5 or 6 mm. long, oblong, rounded at apex, spreading; petals (as in the genus) none; stamens united into a tube 2 mm. long; anthers 10 to 12, sessile, ovate, alternating with small hairy-tipped staminodes; ovary pubescent; style 6 mm. long, extending beyond the stamens; carpels 3.

---

[1] As the genus Nesaea is now understood we have only the two above species in America. The following key seems to separate them:

* *Leaves auriculate at base, the margin revolute; petals small (6 mm. long); calyx tube 4 mm. long, twice longer than the lobes; stamens inserted at the base of the calyx tube; ovary sessile (?).*

N. LONGIPES Gray, Pl. Wright. **1**: 68. 1852.

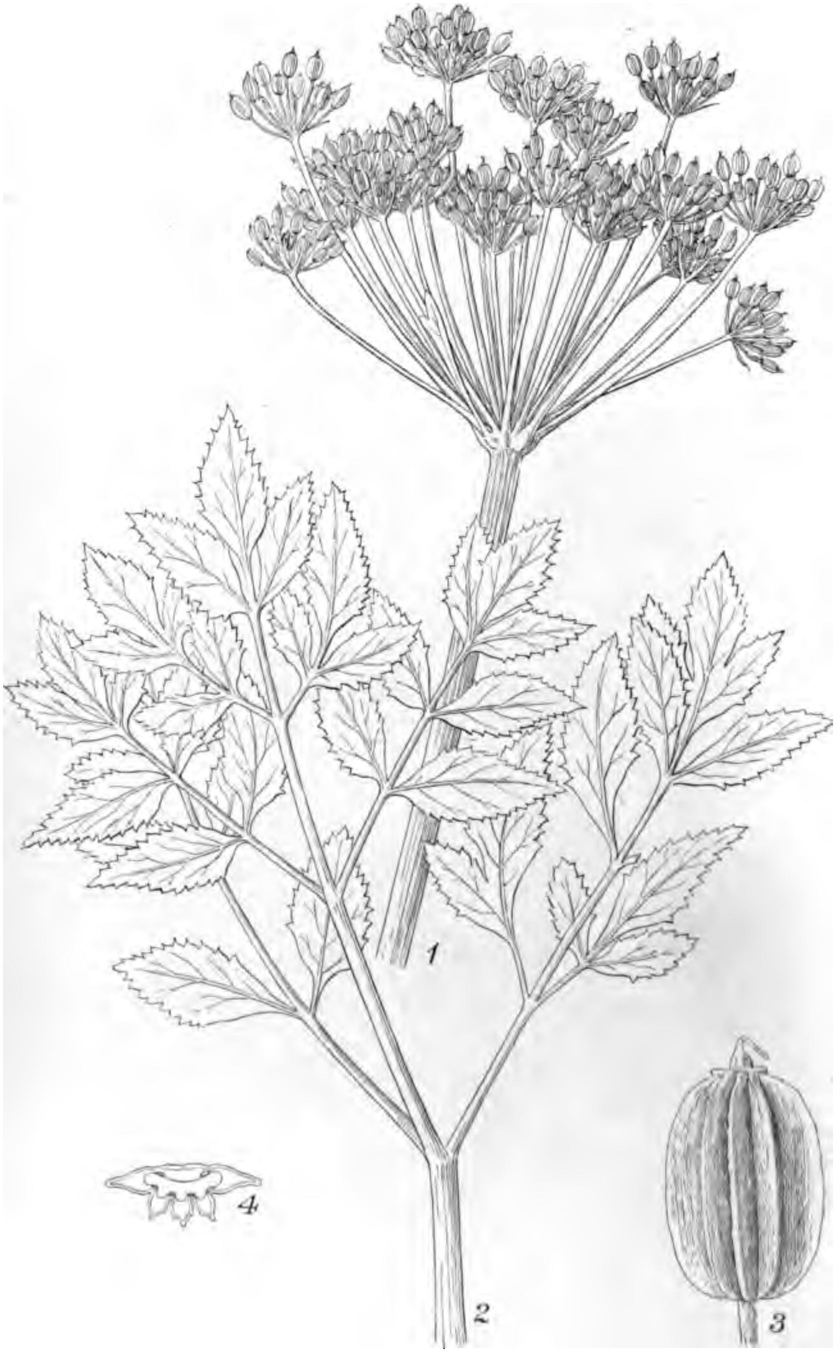
* * *Leaves not auriculate at base, the margin not revolute; petals large (10 mm. long); calyx tube 6 mm. long, three times longer than the lobes; stamens inserted near the middle of the calyx tube; ovary stipitate.*

N. PRINGLEI Rose, supra.

[2] Contr. Nat. Herb. **2**: 112. 1891.

Collected by Dr. E. Palmer at Acapulco, November, 1894 (No. 81). The type. Here, perhaps, also belongs Sinclair's plant from the same locality referred to Samyda by Hemsley without specific name. Specimens collected by Dr. Palmer at Manzanillo in 1890 (No. 1812), and others by M. E. Jones at Colima in 1892 (No. 72), probably also belong to this species, although the pedicels are much longer.

With the exception of two very uncertain species the above is the only Mexican representative of this genus.



ANGELICA ROSEANA Henderson.

TWO NEW SPECIES OF PLANTS FROM THE NORTHWESTERN UNITED STATES.

By L. F. HENDERSON.

Aster latahensis Henderson, sp. nov. (Section Vulgares.)

Stem slender, 0.6 to 1.5 meters high, woolly-pubescent and scabrous, tomentulous among the heads, bearing numerous nearly erect branches near or above the middle; leaves lanceolate, entire, rather thick, with margins slightly inclined to be revolute, strigose and very scabrous, especially on the margins; lower even 15 cm. in length, including the long, petiole-like base, by 2.6 cm. in width; upper gradually shorter, sessile on a scarcely narrowed base, some with the base broad and inclined to be decurrent, or at times even slightly cordate; those on the secondary branches small and narrow, gradually passing into the involucral scales; involucre from 6 to 12 mm. high, in the fully developed heads averaging 11 mm., in 3 or 4 moderately unequal rows; its outer scales commonly foliaceous, obtuse, green, and pubescent, the inner gradually narrowed, acute and with whitened coriaceous bases, some or occasionally all with a narrow hyaline margin; rays 5 or 6 lines long, violet to purple, handsome; disk-flowers generally a bright purple when fresh, sometimes yellow, with yellowish-white pappus; akenes narrow, flattened, strigose-pubescent, strongly nerved with 4 or 5 darker nerves; receptacle deeply alveolate, the teeth of the alveolations sometimes terminating in delicate bristles.

A very handsome species, common on the prairies or slightly-wooded hills of American Ridge, Latah County, Idaho. (No. 2987.)

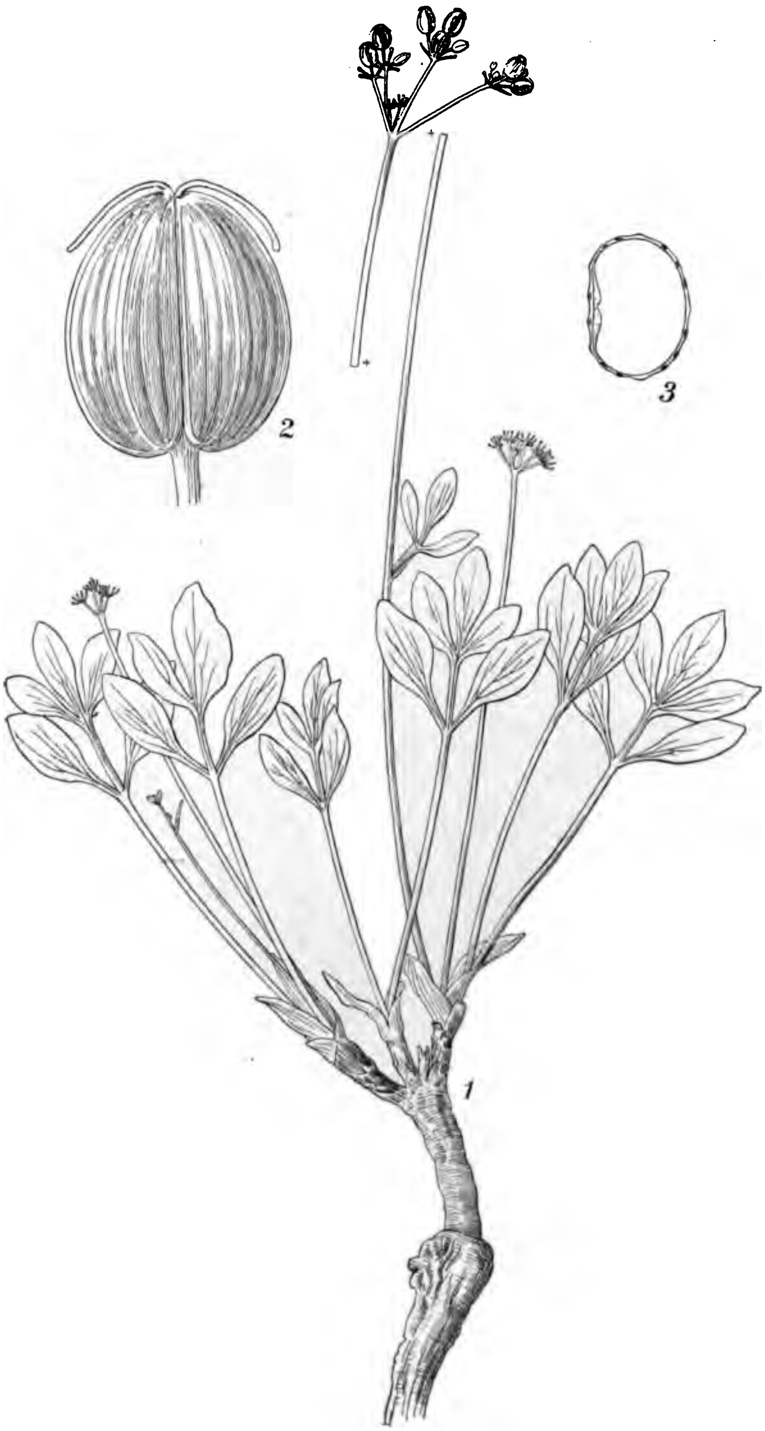
Angelica roseana Henderson, sp. nov. PLATE XXVI.

Five-tenths to 0.6 meter high, very stout for its height, glabrous nearly or quite up to the involucels, scabrous among the flowers, radical leaves triternate, the ultimate divisions frequently pinnate with 3 or 5 leaflets, or occasionally ternate-quinate; upper cauline leaves reduced, with large, inflated petioles, the latter, as well as the inflorescence, scabrous with retrose prickles, which become rounded papillæ among the flowers and on the fruit; leaflets broadly ovate to lanceolate in the lower leaves, in the upper often narrowly lanceolate, thick with prominent veins, lacinate-dentate, with somewhat retrorsely mucronate teeth, the margin between the teeth scabrous, an inch to an inch and a half long, obtuse or acute; umbels, commonly 3, all more or less fertile, without involucre, or involucrate with one or two ligulate generally 3-lobed bracts; the umbellets subtended by a few filiform and very scabrous bractlets, the rays very unequal; flowers green or the majority of them green at base and purplish brown above; petals strongly incurved; stylopodium somewhat conical; fruit broadly oblong-elliptic, glabrous, save the papillæ, 4 or 5 millimeters long; dorsal ribs nearly as prominent as the lateral, corky, the cut surfaces appearing broadly ovate; oil tubes for the most part single in the intervals, two on the commissural side; seed sulcate beneath the oil tubes, strongly concave on the face.

Banks of dried, gravelly rills, foothills of the Lost River Mountains, Fremont County, Idaho. Also collected by John B. Leiberg (No. 3003); Aven Nelson, 1897 (No. 3493), and by P. A. Rydberg.

This plant serves well as a connecting link between Selinum and Angelica. I take pleasure in dedicating the species to Dr. J. N. Rose, of the National Museum, to whom, in connection with Dr. John M. Coulter, I am under obligations for many favors. (No. 4065.)

Explanation of Plate.—Fig. 1, a fruit umbel; fig. 2, a leaf; fig. 3, a carpel, dorsal view; fig. 4, cross section of carpel. Figs. 1 and 2, scale ⅔; figs. 3 and 4, scale 5.



HESPEROGENIA STRICKLANDI Coult. & Rose.

HESPEROGENIA, A NEW GENUS OF UMBELLIFERAE FROM MOUNT RAINIER.

By JOHN M. COULTER and J. N. ROSE.

Hesperogenia Coult. & Rose, gen. nov.

Calyx teeth obsolete; stylopodium wanting; fruit flattened laterally, nearly orbicular or shortly oblong, rounded at base and apex, glabrous; carpels nearly terete in section, with equal-indistinct, filiform ribs and thin pericarp; oil tubes 2 to 3 in the intervals; seed face broad, slightly concave. Low acaulescent plants; leaves once or twice ternate, with broadish segments. Umbel of few unequal rays without involucre and with one or two involucel bracts. Flowers yellow.

This genus is nearest to Museniopsis, but differs especially in its broad seed face, which is never involute or deeply concave. In the seed face it approaches Eulophus and Pimpinella, but differs from both in not having a conical stylopodium and from the former, also, in its yellow flowers. The shape of carpels and ribs suggests *Velaea glauca*, but the seed face is not of the Velaea type.

Hesperogenia stricklandi Coult. & Rose, sp. nov. PLATE XXVII.

Root deep-seated, somewhat tuberous-thickened, crowned with a slender rootstock (?); leaves 3 or 4, all basal, without stipular bases, ternate or biternate, the segments lanceolate, acute, 12 mm. long, glabrous; petioles 3.8 to 5 cm. long; scape 7.5 to 10 cm. long, either naked or with a small bract-like leaf; rays 3 to 6, some of the sterile as well as the fertile ones short (4 mm. long), others 14 mm. long; fruit 2 mm. long, either sessile or on pedicels 4 mm. or less long; styles long, reflexed.

Collected on Mount Rainier, Washington, altitude 2,000 meters, by Percy Strickland in 1896 and by O. D. Allen, August 30, 1897, and September 6, 1898 (No. 278); also by J. B. Flett in grassy meadows on north side of mountain, altitude 1,540 meters, August, 1897.

Mr. Piper writes to Mr. Rose that he also collected the plant on the south side of the mountain in 1895.

EXPLANATION OF PLATE.—Fig. 1, plant; fig. 2, fruit; fig. 3, section of carpel.

THREE NEW SPECIES OF TRADESCANTIA FROM THE UNITED STATES.

By J. N. Rose.

The beginning of my studies on the genus Tradescantia dates back some seven years. During this time an immense amount of material has passed through my hands. The National Herbarium has undoubtedly the largest collection of American Tradescantias ever brought together. For instance, we now have 110 sheets of the old *T. virginiana.* Not only have I been collecting herbarium material, but I have grown a number of species.

I am now preparing a monograph of the United States species of the genus, and it is my intention to illustrate all the species with colored plates. A part of these illustrations have already been made.

Botanists will confer a great favor if they will send me not only herbarium specimens, but roots. I should prefer to have the herbarium specimens collected this season and roots from the same clumps sent late in the fall. When this can not be done the roots of flowering specimens may be sent at once. I desire specimens not only of the rarer species and of plants from out-of-the-way places, but of many of the so-called forms of what is generally known as *T. virginiana* from all of our Eastern States. Franks will be furnished upon application for sending material.

My studies of the western Tradescantias have revealed three undescribed species. Two of these I have never seen outside of the National Herbarium, while the other is not uncommon, having been distributed by many collectors as a form of *T. virginiana.* All three have flowered for two seasons in Washington and one has been under observation for four years. These species may be described as follows:

Tradescantia humilis Rose, sp. nov.

Stems low, 3 dm. or less high, at first simple, but becoming much branched at base and spreading, with more or less roughish pubescence; leaves short, dark green, oblong-linear, with rough pubescence; umbels usually several, sometimes 10, terminating stem and branches, more or less peduncled; involucral leaves more or less unequal, sometimes reduced to one, very similar to other leaves; pedicels and ovary more or less glandular; sepals narrow, acute, glandular-pubescent, and with a tuft of simple hairs near the tip; petals pale blue or pink, obtuse.

Specimens examined—

Eastern Texas:

Near Austin, *E. Hall* (No. 669), 1872.
Near Industry, *H. Wurzlow*, 1895, 1896, 1897.

The type of this species is Mr. Wurzlow's 1895 plant deposited in the National Herbarium.

Specimens have been grown in Washington since 1895.

Tradescantia gigantea Rose, sp. nov.

Plants growing in clumps; stems stout, thick, upright, glabrous and glaucous below, 6 to 10.5 dm. high, more or less branching, the branches slender and erect; leaves large, oblong-linear, 3 dm. or so long, 12 to 36 mm. wide, dark green above, pale green and glaucous beneath, glabrous except the margin; sheath glabrous; top of stem and base of involucral leaves covered with a short, dense, almost velvety pubescence; involucral leaves 2 or 3, short, their bases much enlarged; flowers very numerous, 50 or more; pedicels soft-pubescent, not glandular, 30 to 40 mm. long; sepals boat-shaped, 10 mm. long, acute, pubescent, but not glandular; petals blue or pink, with white form; ovary pubescent, but not glandular.

Specimens sent by Otto Locke, New Braunfels, Tex., April 14, 1897. Also by F. G. Schaupp, Shovel Mount, Burnet County, Tex., April 21, 1897. These specimens are unlike any others which we have seen.

This is an extremely large, coarse plant. It is a very abundant bloomer, producing immense clusters of flowers. It is readily recognized by its almost velvety peduncles, pedicels, and sepals.

Tradescantia scopulorum Rose, sp. nov.

Stems rather low and very slender, 4 dm. or less high, more or less branching, pale and glaucous, mostly glabrous throughout; radical leaves numerous, linear, generally erect, stem leaves similar, very narrow (2 to 10 mm. wide); sheath very short and turgid; involucral leaves filiform, somewhat unequal, much shorter than the leaves; umbels sessile, rather numerous, terminating stem and branches; pedicels slender; sepals narrower; petals very pale blue, acute.

Arizona to Texas, north through Colorado to Montana, perhaps extending into western Nebraska. The type of this species is the plant found by Mr. Pringle in the Santa Catalina Mountains, Arizona. Its range is not well defined, but I have assigned to it all those forms which have been referred to *T. virginiana* from western Texas, Arizona, New Mexico, Utah, Colorado, Montana, and western Nebraska. Specimens sent me by Mr. George Osterhout from western Colorado are very pubescent in the umbel, but in other respects like the type.

This species has generally been referred to *T. virginiana* with doubt, or mentioned as the "narrow-leaved western variety," and so far as I can learn no name has been assigned to it. It appears to be quite distinct from typical *T. virginiana*, and can be identified at a glance by one familiar with the genus. It is not easy, however, to express these differences, and on this account some of my statements above may need revision. Briefly, it differs from true *T. virginiana* in its slender branching habit, slender and glaucous leaves, and numerous flowering umbels, as well as in its very distinct range.

Specimens examined—

Arizona:

By streams of the Santa Catalina Mountains, *C. G. Pringle*, May 16, 1881 (type).
Flag Staff, *D. T. McDougal*, July, 1891.
Pinal Mountains, *J. W. Toumey*, July 20, 1892 (No. 439).
———, *Dr. E. Palmer*, 1869.
Oak Creek, *H. H. Rusby*, June, 1883.
Holbrook, *Mrs. Myrtle Zuck Hough*, August 22, 1896.
Snowflake, *Mrs. Myrtle Zuck Hough*, August 7, 1897.

Colorado:

New Windsor, *Geo. E. Osterhout*, June, July 4, 1895.

Colorado Springs, *F. H. Knowlton*, June 15, 1896 (No. 33).

Along the Platte River, Denver, *Marcus E. Jones*, June 12, 1878; Denver, *E. Bethel*, June, 1893.

New Mexico:

——— *C. Wright*, 1851-52 (Nos. 1928 & 1929).

Valley of the Rio Grande, below Doñana, *C. C. Parry*, etc. (No. 1498).

Nebraska:

On Middle Loup River, near Thedford, Thomas County, on sand hills, *P. A. Rydberg*, June 18, 1893 (No. 1380).

Indian Territory:

Fort Smith to the Rio Grande, banks of the Canadian River, *Dr. J. M. Bigelow*, 1853-54.

Montana:

J. W. Blankinship, June 3, 1890 (No. 57).

TRELEASEA, A NEW GENUS OF COMMELINACEAE.

By J. N. Rose.

Treleasea Rose, gen. nov.

Sepals distinct, concave, subequal, greenish or scarious. Petals distinct, tapering at base into a slender claw, cohering and forming a slender tube. Stamens 6, all perfect, subequal, more or less hairy, borne on the petals. Style slender, 3-lobed. Capsule stipitate, 3-celled. Cells dehiscent, 2-seeded. Perennial herbs from tuberous roots. Cymes sessile, many-flowered, either in terminal or axillary clusters.

This name is given in honor of Dr. William Trelease, director of the Missouri Botanical Garden, whose well known services to botany and horticulture deserve this recognition.

This genus differs from Tradescantia, especially in the corolla and the position of the stamens. Tradescantia has always an open flower spreading from the base, with petals broad at base, while Treleasea has the petals tapering into a claw, forming a tube and only spreading toward the top. The stamens, too, are always free in Tradescantia, while in Treleasea they are borne on the petals.

The genus seems nearer Cyanotis than Tradescantia, but differs from that in its stipitate fruit, concave sepals, etc. It is perhaps nearest Zebrina, differing chiefly in the fact that the petals are not united into a tube, but merely cohere at the edges.

I have long been dissatisfied with the reference of the species *brevifolia* to Tradescantia, having had the plant under cultivation since 1895. While in Mexico in 1897 I found another plant of similar habit with the same flower structure, showing that this is a good generic type. *T. leiandra,* although the flower structure is doubtful, possesses the stipitate fruit and otherwise suggests that it belongs here also.

The genus, as I now understand it, consists of the three following species, of which *brevifolia* is the type:

Treleasea brevifolia (Torr.) Rose, nom. nov. *Tradescantia* (?) *brevifolia* Rose, Contr. Nat. Herb. **3**:323. 1895. *Tradescantia leiandra brevifolia* Torr. Bot. Mex. Bound. 225. 1859. *T. speciosa* Buckley, Proc. Acad. Phila. **1862**:9. 1863. Not L. or H. B. K. *Zebrina* (?) *leiandra* Clark, in DC. Monogr. Phan. **3**:318. 1881. *T. leiandra* Wats. Proc. Am. Acad. **18**:167. 1883. Not Torr. Same, Hemsley, Biol. Centr. Am. **3**:393. 1885. *T. leiandra ovata* Coulter, Contr. Nat. Herb. **1**:50. 1890. Same, l. c., **2**:444. 1894.

Stems prostrate, leafy to the top; leaves approximate, ovate, 2.5 to 7.5 cm. long, 2.5 cm. wide, thickish, glaucous and glabrous, except the ciliate-scabrous margins, acute; margin of sheath ciliate; involucral leaves 2, like the lower leaves, but smaller; umbel sessile, many-flowered; corolla white, petals ovate, obtuse, somewhat spreading, tapering at base into a slender claw, stamens erect, longer than the petals, hairy near the middle, attached to petals; ovary hairy near the top.

For a number of years past this species has been cultivated in Washington, both in the greenhouses and in the gardens. In the greenhouses it grows luxuriantly under the benches. The foliage is of a glossy bright green, and in all cases the flowers have been white, usually appearing singly.

For a full discussion of this species and its relationships with *T. leiandra* see Rose in volume 3 of this publication, pages 322, 323.

Treleasea leiandra (Torr.) Rose, nom. nov. *Tradescantia leiandra* Torr. Bot. Mex. Bound. 224. 1859.

Roots slender, fibrous-thickened; stems erect, somewhat branching, slender, glabrous, somewhat naked above; leaves distinct, narrowly lanceolate, 7.5 to 12.5 (perhaps more) cm. long, 12 mm. wide, sharply acute, with margins not scabrous; margin of sheath glabrous or nearly so; involucral leaves 2, ovate, acuminate, 2.5 to 3.5 cm. long, very unlike the lower leaves; umbel sessile, many-flowered; pedicels and sepals densely villose; filaments smooth; capsule oval, somewhat 3-lobed, stipitate; cells 3, 2-seeded; seeds 1 mm. in diameter, slightly rugose.

Collected by Bigelow in mountains and moist rocky places at Puerto de Paysano, Tex., September 18, 1854 (?) (No. 1500), and by V. Havard at Capote Creek, Texas, September, 1883 (No. 79).

Treleasea tumida (Lindley) Rose, nom. nov. *Tradescantia tumida* Lindley, Bot. Reg. **26**: *t. 42*. 1840. *Tradescantia virginiana tumida* Clark, in DC. Monogr. Phan. **3**: 291. 1881.

The figure cited above, although very unsatisfactory, seems to represent the same species as I collected on the western border of the Mexican table-lands. It has the same reddish flowers borne in dense axillary clusters, and the petals taper down into claws (here represented as united). The leaves are also described as purple beneath. This illustration of Lindley's was made from a plant which flowered in the garden of the Horticultural Society in 1839.

Nothing more of the history of the plant is given than that it came from Mexico. It is not unlikely that this plant was sent in by Hartweg from the same region from which mine came. In 1836 and 1838 he visited Bolaños and the neighboring region and was sending many plants home to the Horticultural Society, by whom he had been sent to Mexico. I should state, however, that I have looked through Hartweg's lists of plants, which he said were growing in the gardens, without finding any mention of a Tradescantia.

The following redescription of this species is based upon my own specimens, both herbarium and living:

Stem from tuberous-thickened roots, rather low, very succulent, often very compact; leaves oblong, 12 to 18 cm. long, acute, more or less pubescent; flowers borne in dense axillary and terminal clusters; pedicels about 10 mm. long, glabrous; sepals glabrous or nearly so, oblong, 8 mm. long; petals pink; stamens slightly hairy; capsule stipitate, reflexed; hairy at tip.

This species seems to be common in damp, sheltered places in the western table-land regions of Mexico, especially in canyons and along cliffs. It was first brought in by Mr. Goldman, and afterwards collected by myself.

Collected by J. N. Rose at San Juan Capistrano, Zacatécas, August 23, 1897 (No. 2486); near Monte Escobedo, Zacatecas, August 27 (No. 2660), and at Bolaños, September 10 to 19 (No. 2890).

Specimens are now growing in the Botanical Garden at Washington. This species is so common in the table-land region of Mexico that it seems strange that it is not in the recent collections from Mexico.

Clark's reference of this species as a variety of *T. virginiana* and statement that it can hardly be distinguished from var. *flexuosa* (*T. pilosa*) can not be entertained.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

NOTES ON USEFUL PLANTS OF MEXICO.

BY

J. N. ROSE.

Reprinted from Contributions from the U. S. National Herbarium,
Vol. V, No. 4, issued October 31, 1899.

CONTENTS.

	Page
Introductory statement	209
Cereals and vegetables	210
Fruits	214
Beverage plants	223
Seasoning and flavoring plants	226
Medicinal plants	227
Soap plants	231
Tanning and dye plants	237
Fiber plants	239
Brush and broom plants	252
Fence and hedge plants	253
Plants yielding wood	255
Miscellaneous useful plants	256

ILLUSTRATIONS.

Page.
Pl. XXVIII. Fruits and tortilla 212
XXIX. Ciruelas—fruit of *Spondias* spp 219
XXX. Garambullo (*Cereus geometrizans* Mart.) 220
XXXI-XXXIII. Pulque plants or maguey (*Agave atrovirens* Karw.) 224
XXXIV. Rootstocks of an agave (Manfreda) used for soap 234
XXXV. Guerrero Indians bringing palm leaves from the Pacific. 240
XXXVI. Hat braids made from sotol and soyate 241
XXXVII. Articles made from sotol and soyate leaves 241
XXXVIII. Isote (*Yucca treculeana* Carr. (?)) as seen near the Piramide del Sol, northeast of the City of Mexico 241
XXXIX. Cogollos of plants furnishing Tampico hemp 243
XL-XLI. Small bunches of Tampico fiber 243
XLII-XLIII. Strings made by hand from Tampico fiber 243
XLIV-XLV. Mexicans making bagging out of ixtle fiber 243
XLVI. Process of twisting ixtle fiber into twine 243
XLVII. Lechuguilla plant with burro 248
XLVIII-XLIX. Instruments used in extracting ixtle fiber 248
L. Articles made from ixtle fiber 250
LI. A fiber twister 250
LII. Agave fiber and manufacturing implements 250
LIII. Cotton fiber and implements 251
LIV. Brushes of palm leaf and grass 252
LV. Hairbrushes made from Tampico fiber 252
LVI. Brushes made from several kinds of fiber 252
LVII. Hairbrush made from a fruit of *Cereus pecten-aboriginum* Engelm 253
LVIII. *Cereus pecten-aboriginum* Engelm 254
LIX-LX. Organo (*Cereus marginatus* DC. (?)) used for fences near the City of Mexico 255
LXI. Wooden articles 256
LXII. Sacred cactus (*Mammillaria senilis* Lodd.) 258
LXIII. Vessels made from Crescentia fruits 259
LXIV. Gourd used for a water vessel 259
Fig. 31. Huamuchil, *Pithecolobium dulce* Benth 216
32. *Cereus pecten-aboriginum* Engelm 254

NOTES ON USEFUL PLANTS OF MEXICO.

By J. N. ROSE.

INTRODUCTORY STATEMENT.

In presenting these notes upon the plants which are employed in one way or another by the Mexicans I wish them to be understood as chiefly a record of my own observations. A more formal and complete treatise is already in preparation by the Mexican Government, by whom it naturally should be done, but it is hoped that this paper may be of assistance in supplementing that work. My observations, in many cases meager and incomplete, were made while traveling in Mexico in 1897. I have drawn little upon published statements, contenting myself with facts personally observed or with well-authenticated reports obtained from the Mexicans themselves. Many of my observations may, doubtless, have been previously made, but I was especially fortunate in obtaining and determining botanically a number of plants which heretofore have been incorrectly named, or have been known only by their local names. An attempt was made in the case of each species to obtain both good botanical specimens and examples of the parts or products of the plant useful to man. That the results are not entirely satisfactory is partly owing to the shortness of my stay in any one place, which was usually but for a day or two, often only for the night.

To obtain the fullest information from the natives, and especially from the Indians of the Sierra Madre, one ought to spend considerable time among them. Naturally suspicious and shy, it is not surprising that one can not readily obtain information from them. But if one could live with them for a short time, treat them kindly, and gain their confidence, he could, with a free use of coppers and small silver change, soon have the contents of their homes and their knowledge at his disposal. One other hindrance to my work was a lack of equipment for a long inland journey. In one case I traveled nearly 600 miles on horseback, and of course could not carry many fleshy fruits, berries, or other bulky things.

Among some of the interesting enterprises suggested by my observations which might be taken up by our Government the following may be mentioned:

(1) The introduction of the best Mexican tunas into the subarid parts of our Southwestern States and the encouragement of the impor-

tation of tuna fruits from Mexico into our Eastern cities, as they are now being imported from Sicily.

(2) An investigation of the Tampico hemp industry, with a view of making use of the agave plants of western Texas or of growing better varieties on the waste lands in some of our Southwestern States; also some supervision of the importations to prevent adulterations with cheaper and worthless fibers.

(3) The introduction and testing of certain vegetables, such as beans and red peppers, and certain fruits, like the Mexican plums (ciruelas).

(4) The gathering of a collection of all the various products used by the Mexicans and Indians which are made from the agave. Such a collection would include many hundred specimens, for there is no plant in Mexico which has so many and varied uses.

(5) A botanical study of the genus Agave in the field and the preparation of numerous photographs and specimens.

(6) The institution of a full collection of living agaves. These should be placed in the Botanic Garden at Washington.

(7) A study of the pulque and mescal plants with the view of determining definitely the species used in the production of those beverages.

These various plants being of great economic value to the Mexican people, assistance would doubtless be given by the Mexican Government toward any investigations along this line. Indeed, assistance has already been offered by the Instituto Medico Nacional.

CEREALS AND VEGETABLES.

The food plants of the country are very many. Those, however, which may be said to be almost universally used are indian corn, red peppers (Capsicum spp.), "tomatoes" (Physalis spp.), and beans.

Zea mays L.

In the towns wheat bread and cakes can easily be had, but in the country, both in the mountains and in the table-land region, one finds only corn bread or, more properly, corn cakes. The corn cakes are called "tortillas" (Pl. XXVIII, fig. 2), and are made out of corn meal. The corn is first soaked in limewater to soften it and is then mashed or ground by hand between stones into a kind of dough. This dough, without any other ingredients, not even a pinch of salt, is then molded or rather patted between the hands into thin cakes, which are baked on clay griddles. The "tortillas" are torn in pieces and eaten alone or used in scooping up beans or soup, thus taking the place of spoons and forks. The work of grinding the corn and making the cakes is all done by women. More than once I have come to a Mexican's hut after a long day's ride, tired and hungry, and found that I had to wait until the woman of the house had made her little fire on the ground, mashed her corn on her "metate," patted it into little cakes, and baked them. For the first meal these tortillas are served hot, being brought directly from the griddle and passed about in a gourd or clay dish, covered with a rag or cloth.

A great number of tortillas are usually baked at one time and are served, until they are gone, cold or else warmed simply by throwing them on a bed of live coals. Sometimes cold beans or cheese are folded up in one of them, and it is then called "gordo," meaning "fat one."

Capsicum spp. CHILE.

Many kinds of red peppers are used both in seasoning food and in making chili sauce. This sauce is made by crushing red peppers (usually the long red ones) with ripe tomatoes on the metate, or sometimes the crushing is done in a clay dish with a pestle. It is used with nearly all kinds of food, especially with beans and meats. Although I brought back only 8 varieties there must be many more kinds grown in Mexico, and it certainly would be a very interesting undertaking to collect and classify the varieties used. The Department of Agriculture could very properly and profitably take this subject up in connection with the plant-introduction work. I have named my specimens, with the assistance of Mr. Irish, according to his excellent monograph recently published in the Report of the Missouri Botanical Garden, but only with partial success, as some of my plants seem not to belong to varieties now in the trade. These varieties, with their Mexican names, may be described briefly as follows:

"Chile mirasol" is an oblong red pepper 2.5 to 3.75 cm. (1 to 1½ inches) long. I purchased it in the market at Guadalajara. It is said to be the fruit of *Capsicum frutescens*, but seems very different from the next.

"Pequin," the fruit of *Capsicum frutescens*, was found in the markets in the City of Mexico. It is very small, 10 to 12 mm. (5 to 6 lines) long, oblong to ovate, and red.

"Chile pequin," the fruit of *Capsicum annuum cerasiforme*, was purchased in the market at Guadalajara. The fruit is red, nearly spherical, and only slightly larger than the last.

"Chile," the fruit of *Capsicum annuum longum*, is perhaps the commonest form to be seen in the western table-land region. The fruit is found in all the markets. It is red, or blackish in some forms, oblong to oblong-linear, and 10 to 15 cm. (4 to 6 inches) long. My specimens were purchased in the markets of Guadalajara and Monte Escobedo, in western Zacatecas.

"Chile cara" is the name for a smaller fruit form, which Mr. Irish also calls *Capsicum annuum longum.*

"Chile" is the name given me for the fruit of *Capsicum annuum acuminatum* Fingerh. This pepper is red, slender, somewhat acuminate, and about 5 cm. (2 inches) long.

"Chile ancho" is the fruit of *Capsicum annuum grossum*. The fruit is black, 10 cm. (4 inches) long, and 8.75 cm. (3½ inches) broad. I saw it only in the markets at Guadalajara.

Physalis spp. TOMATO.

Various species of Physalis are always to be seen in the markets. The fruits are called "tomatoes," and are used to make a dressing for meats, etc., or are combined with red peppers to make chili sauce. (Pl. XXVIII, figs. 3, 4.)

EXPLANATION OF PLATE XXVIII.—Fig. 1, tamarinds; fig. 2, tortilla or corn cake; figs. 3, 4, "tomatoes"—fruits of *Pysalis* spp.

Phaseolus spp. FRIJOL.

The bean is, next to corn, the most important food plant of Mexico. In fact it is used all over the country. No meal is complete without a dish of beans, while many a meal consists of nothing else. It is cultivated everywhere, from the low tropical plains to the high mountain tops. Many varieties are found in the markets, some of which undoubtedly have been introduced into cultivation from native plants, while others have certainly come from foreign countries, but have long been grown in Mexico.

Nearly 50 native species of Phaseolus have been reported from Mexico and Central America, and I have no doubt but many yet remain undescribed. I collected myself some 10 wild species, about half of which I have not definitely identified. As is well known, some of our most common varieties of beans came originally from several of the wild species of Mexico.

I am quite sure that new and valuable varieties suitable for cultivation in the United States might be obtained from the markets of certain cities of Mexico. It seems to me that some money might very profitably be spent by the Department of Agriculture in connection with its seed introduction in obtaining and distributing some of the best varieties of Mexican beans.

In compliance with my instructions, I obtained about 20 varieties, but only in small quantities, as my equipment and the fund at my disposal did not warrant a greater outlay.

I have compared my beans with the large series in the seed collection of the Department of Agriculture, but I do not find over three varieties represented. In the accompanying list I have briefly described them as to color and have in most cases given the Mexican name of each.[1]

No. 49. FRIJOL APASTEADO.

This is a small purplish bean, somewhat mottled with buff, much used at Bolaños.

No. 50. FRIJOL.

A small roundish pinkish bean also used at Bolaños.

No. 83. FRIJOL HORTELANO.

A small buff bean sold at Colotlan.

No. 104. FRIJOL BLANCO (*Phaseolus lunatus* L.?).

A dwarf white bean cultivated at Acaponeta. Apparently the same form as cultivated in this country.

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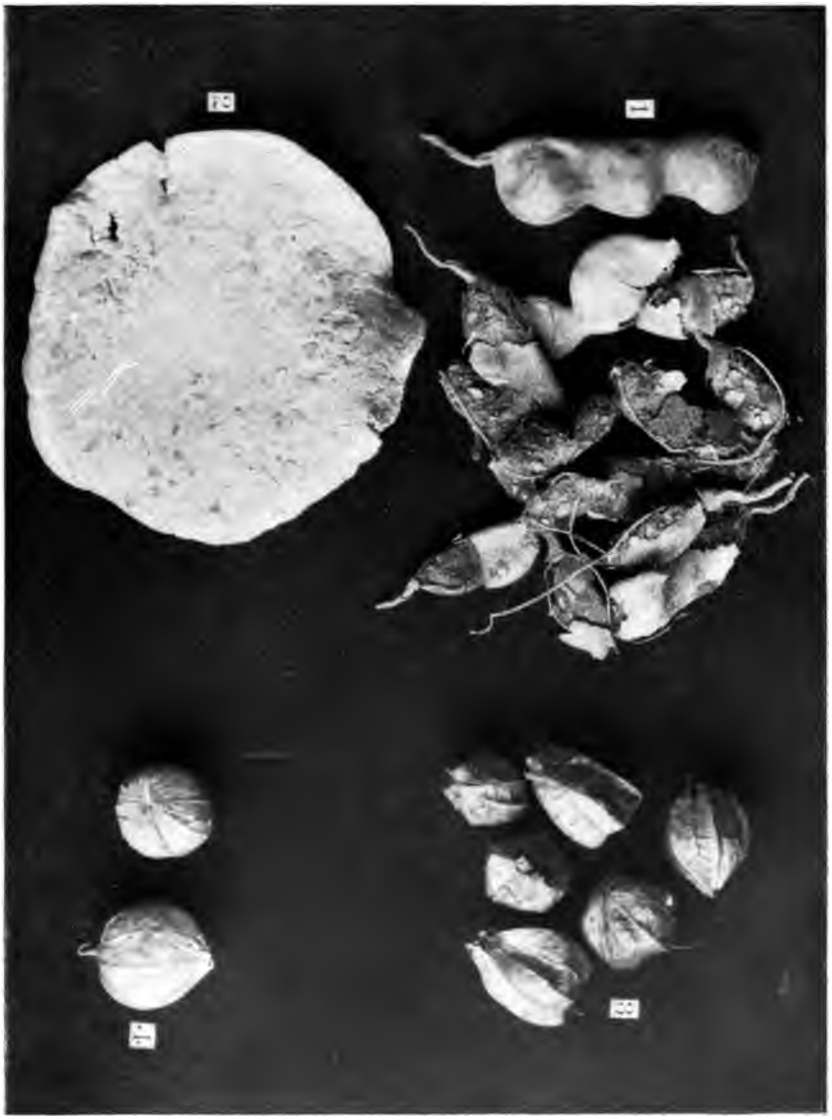
[1] The numbers refer to the Ethnobotanic collections of the author

PLATE XXVIII.



FRUITS AND TORTILLA.

No. 85. **FRIJOL ENCREVADO.**

A small drab-colored bean. Seed not very pure, but mixed with black, whitish, and purple beans.

No. 86. **FRIJOL BLANCO NALLADO.**

A small, light drab-colored bean. Seed not very pure.

No. 87. **SEMILLA DE GICAURA.**

A small 4-sided somewhat flattened seed of dark or light-brown color. Probably not a Phaseolus.

No. 89. **FRIJOL GARVANODE PICACHOS.**

A small light tan bean.

No. 90. **FRIJOL NUEVO TEMPRANILLO.**

A small, shortly oblong bean of somewhat greenish cast.

No. 91. **FRIJOL MEXICANO.**

An oblong light-brown bean.

No. 92. **GARVANCILLO VERDE.**

A somewhat globular greenish-colored seed.

No. 93. **FRIJOL CANDO.**

A small brownish-pink bean.

No. 94. **FRIJOL GUERO.** (Large white pole.)

A small oblong white bean.

No. 95. **GARVANZO DE PICACHOS.**

A small oblong drab bean.

No. 96. **FRIJOL SEQUIN.**

An oblong dark-red bean.

No. 97. **FRIJOL MORADO BOLA.**

A small purplish-red bean.

No. 98. **FRIJOL MESQUITILLO.**

A small yellowish bean.

No. 99. **FRIJOL NEGRO.** (Wax bean?)

An oblong black bean.

No. 100. **FRIJOL LAVARENO.**

A very pale yellow or cream-colored bean.

Nos. 86 to 100 were obtained at Guadalajara.

No. 101. **FRIJOL.**

An oblong drab colored bean.

No. 102. **FRIJOL.**

An oblong light-brown bean.

Nos. 101 and 102 were obtained in the market of the City of Mexico.

No. 103. **PATOL.**

A large oblong black, reddish, or white bean. Obtained at Colotlan.

No. 125. **FABA VULGARIS.**

This bean was repeatedly seen in the markets and occasionally growing in fields. I was told that it was called "hava," which may be a corruption of "faba."

No. 126 to 128. **CICER ARIETINUM.**

Found in the markets. My seeds are from Mazatlan (No. 127) and Guadalajara (No. 128).

The long roots of a plant called "cudrado" are prepared for eating by being peeled and boiled like potatoes. The fruit, which is about 2 to 2.5 dm. long, is said to be pale green when ripe. It is eaten both raw and roasted. I have not yet been able to identify the plant.

FRUITS.

Mexico has many peculiar and interesting fruits. With its extremely varied climate, almost any kind of fruit can be grown. Only those are here described which came under my observation while making a hasty journey through the country.

Many fruits common in our own markets are also abundant there, such as apples, peaches, pears, bananas, etc. Apples and peaches are seen in all the markets, but I saw only a few orchards. These were in Indian villages on the top of the Sierra Madre at an altitude of 6,800 feet. From here the fruit is carried down the mountain side on backs of donkeys and taken 100 to 200 miles to market. A rude crate is commonly used. This has four nearly equal sides made of small sticks, which are tied together at the corners with agave fiber. The top and bottom are usually made of a layer of leafy twigs (often willow) drawn through the lowest and uppermost openings.

Bananas are very common. Quite a number of varieties were seen. More kinds are met with there than will be seen in our own markets. Bananas grow not only along the coast, but in the hot barrancas of the interior.

Oranges and lemons are found everywhere. At Guaymas there are some large orange orchards, which of course are irrigated. I was astonished at the abundance of limes which are grown throughout the tropical regions. This fruit deserves a greater popularity in the United States than it now has.

I saw pineapples for sale at Guaymas which had been shipped thither from Manzanillo. It is said to be a very profitable crop to grow.

Blackberries are used, but how extensively I did not learn. The wild species seen on the top of Sierra Madre ripens its fruit in August. Apricots are cultivated in Sonora and were for sale at several of the railroad stations. Figs are grown in the gardens at Guaymas.

Cocoanut and date palms are common in many gardens, and the nut of a wild species is brought into the towns in great quantities.

The melon zapote or papaya (*Carica papaya* L.) is a great favorite and is grown in plazas and yards. I found the mango in all the markets. The fruit, which is about 7 to 7.5 cm. (3 inches) long, is always eaten raw. Trees were seen growing up to an altitude of 750 meters (2,500 feet).

PALMACEAE.

Acrocomia sclerocarpa Mart. COCOJUL.

In the markets at Mazatlan, Rosario, and Acaponeta great quantities of a small palm nut are sold. This nut is about the size of a small black walnut. I was told that the outer pulp is first eaten and afterwards the seeds. The nuts are often brought from a long distance. The trees grow only in the foothills and lower mountains.

BROMELIACEAE.

Bromelia spp. COCURSTLE OF COCURSTE.

At least two species of Bromelia are very common on the west coast, and their fruit is often for sale in the markets. In one it is oblong in shape, 6.5 cm. (2½ inches) long, and of a deep purple color. The other is smaller, ovate, and yellow in color. Both are slightly acid to the taste; a drink similar to lemonade is made from the ripe fruit. It is generally eaten raw, but sometimes cooked. It is said in the latter case to resemble apricots.

ANONACEAE.

Anona cherimolia Mill. CHIRIMOYA.

Chirimoya is a very abundant fruit in the markets of Mexico. The annual crop is valued at over $45,000.

The fruit of several species of Anona must go under this name. I found on the streets of Guadalajara two varieties of this fruit, one of which is perhaps *A. longiflora*. The chirimoya is 6.25 to 7.5 cm. (2½ to 3 inches) long, ovate in outline, with a brownish skin, either smooth or tuberculate.

Anona glabra L. ANONA.

A number of fruits go under the name of anona. I collected specimens of three species of the genus, all of which are called by the one common name. The chirimoya also belongs to this genus. I was told that the rough-fruited species of Anona were called chirimoya, while the smooth-fruited ones are called anona.

The anona most largely cultivated is said to be *A. glabra*, of which I collected specimens on the west coast. The annual crop is valued at over $19,000.

LAURACEAE.

Persea gratissima Gaertn. AGUACATE.

The aguacate or alligator pear is a common fruit in the markets of Mexico. It is commonly used as a table fruit eaten raw with pepper and salt, as a salad, in soups, or spread on bread. The fruit is somewhat obovate in outline, 7.5 to 8.75 cm. (3 to 3½ inches) long, containing in the center a large loose seed. Two varieties were seen, one having a green skin with lighter spots, the other nearly black or a dark purple. The pulp is rather firm, in appearance suggesting butter, and hence the popular name "vegetable butter."

The trees are widely cultivated in the tropical and subtropical parts of the country. The annual crop is valued at about $14,000. As is well known, it is not restricted to Mexico but now cultivated in most tropical countries, and some trees are grown in south Florida and California.

The fruit is sometimes sold in our markets, but has never received the attention it deserves.

The following are the names applied to the fruit: Aguacate, ahuacate chico, ahuacate grande, avocado, avocado pear, alligator pear, midshipman's butter, vegetable butter, vegetable marrow.

ROSACEAE.

Couepia polyandra (H. B. K.) Rose. ZAPOTE AMARILLO.

This species is little known botanically. It seems to be common along the west coast of Mexico, where it is evidently native. It grows to the height of 3 to 7.5 meters (10 to 25 feet). The fruit is yellow and about 7.5 cm. (3 inches) long. It is edible, but I was not able to learn whether or not it is extensively used.

The name "zapote amarillo" is also given to *Sapota elongata.*

Crataegus spp. TEJOCOTE.

The fruits of two species of Crataegus were seen in the market at Guadalajara, sold under the name of "tejocote." The fruits are often strung on small strips of isote fiber. About 20 of them are in each strand and the strands sell at a cent apiece. The fruits are made into various jams and jellies.

LEGUMINOSAE.

Pithecolobium dulce Benth. HUAMUCHIL.

The seeds of this tree (fig. 31) are considerably used by the people on the west coast of Mexico, where it has been largely planted. It is found all through tropical Mexico, where it is probably native, but on account of its rapid growth and delicious fruit it has also been much planted. It is very common in yards about towns and along streams.

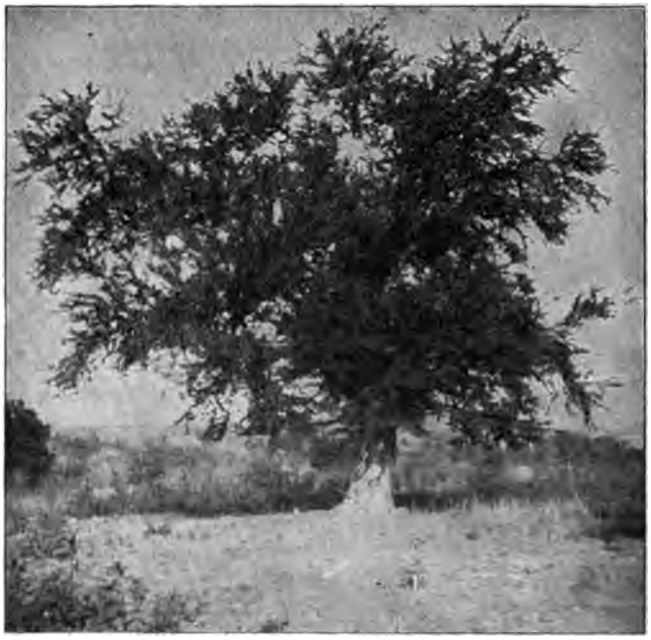


FIG. 31.—Huamuchil, *Pithecolobium dulce* Benth.

When the trees are irrigated they make rapid growth and are said to stand the drought extremely well. Large trees were seen about Guaymas surrounded by almost desert conditions.

The fruits ripen toward the close of the dry season. At Guaymas and Mazatlan they ripen the last of May. The boys and men gather the pods by the basketful and sell them in the streets as bananas are sold in our own cities. The pods and seeds are largely sold in the markets. The latter are often put up in little cone-shaped wrappers, which, with their contents, are sold for a cent apiece. An old tree will produce many bushels of fruit, which is valued at the rate of $25 per tree. The pods are about 10 to 15 cm. long; when mature, somewhat reddish or flesh-colored and irregularly swollen. After the seeds have fallen the valves usually become strongly coiled. The part which is eaten is not the seed proper, but the large, fleshy aril, which almost completely surrounds and hides it, measuring 30 mm. (15 lines) long by 15 mm. (7 lines) thick. The aril is usually white, sometimes reddish, very crisp, sweetish, and very palatable. It is always eaten raw. At first sight it appears to be composed of a single covering, but in reality it is probably composed of many separate series of fleshy cells strongly compressed. The seed proper is small, black, flattened, 10 mm. long.

Pithecolobium ligusticifolium also has a very large aril, but it is not at all edible. The aril is a bright scarlet, much less fleshy and more fibrous than in *P. dulce.*

MALPIGHIACEAE.

Byrsonima crassifolia H. B. K. NANCHE.

Nanche is a wild fruit which is brought into all the markets in great quantities. It grows on a small bush or shrub 1.8 to 3.6 meters (6 to 12 feet) high. The drupe is about the size of a small cherry, yellow in color, and of somewhat acid taste. It is generally eaten raw, but is sometimes put into soups as a flavoring, and sometimes added to the stuffing of tomales.

At Colomas I saw nanche, rice, and olives cooked with stewed chicken.

RUTACEAE.

Casimiroa edulis La Llave. ZAPOTE BLANCO.

I did not see much of this fruit, but it is said to be very common in all the markets. A few specimens were seen at Mazatlan.

The fruit is about 5 cm. (2 inches) in diameter and contains 5 large seeds. The tree is said to be native, but I saw it only in cultivation.

ANACARDIACEAE.

Spondias spp. CIRUELA.

The ciruela or Mexican plum (fruit of the ciruelo) is one of the important fruits of Mexico. The annual crop is valued at over $70,000. In its season it is a universal favorite and is then the most common fruit seen in the markets.

The trees are grown all over tropical Mexico. I saw them in gardens at Guaymas, Mazatlan, Rosario, Acaponeta, and elsewhere, and the fruit in the markets of these towns, as also in those of Guadalajara and the City of Mexico. It is said that the fruit can be profitably raised in all the States of Mexico.

The ciruela tree is 3 to 7.5 meters (10 to 25 feet) high and has a short trunk, usually 8 to 10 inches, but sometimes in old trees 37 to 45 cm. (15 to 18 inches) in diameter, with smooth grayish or even white bark, a very large spreading top, and pinnate leaves. The fruit matures at the very close of the dry season. The branches are then entirely bare of foliage, and have a peculiar aspect, lined as they are with yellow knobs.

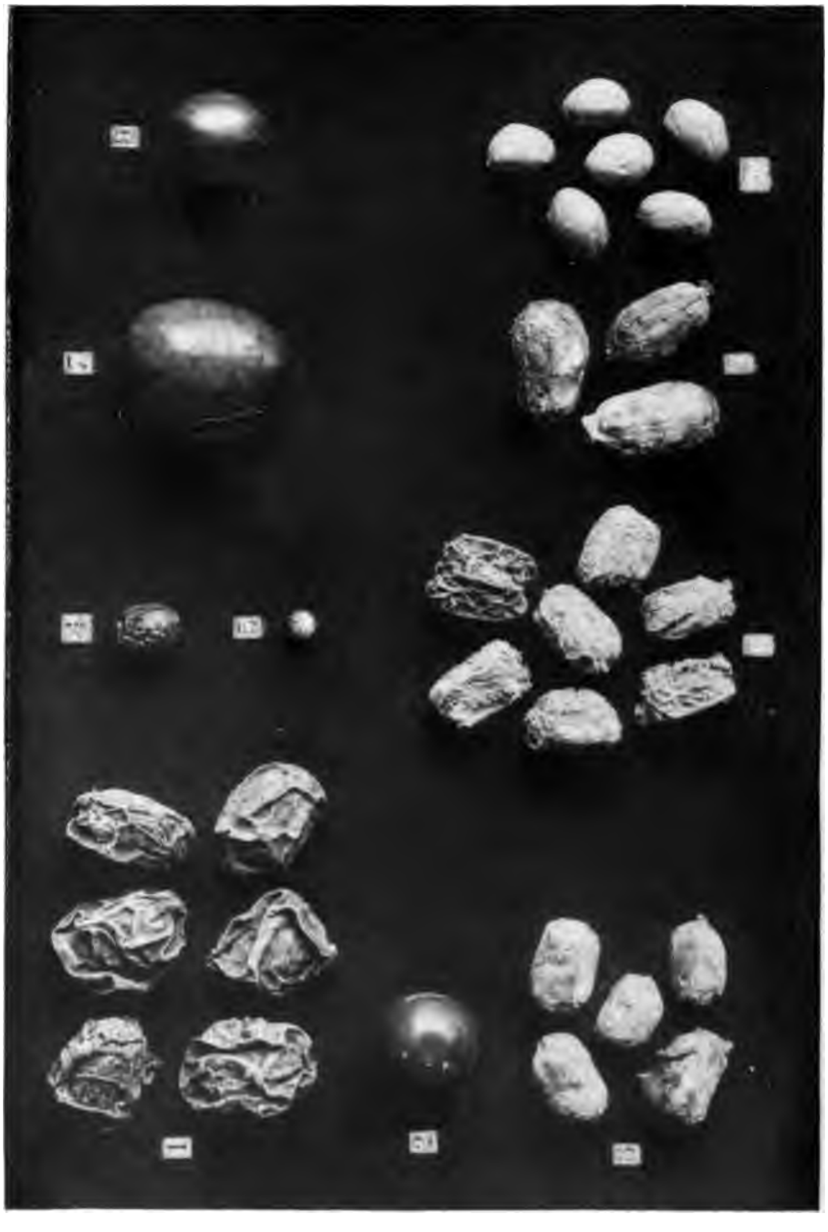
These plums are used in a great many ways. In their season they are seen everywhere; in the larger towns they are hawked about the streets, and in the markets every stall or countryman has a tray or box of them for sale, and retails them 6 for a cent. Both immature (green in color) and well-ripened fruit is sold. The mature fruit is plump, spherical or somewhat ovate in outline, with a rather tough yellow or red skin. The pulp has the consistency and somewhat the taste of the May apple of the North. The fruit is usually eaten raw and is very popular. It is also cooked and used in a number of ways. Sometimes it is served in hotels for dessert or made into "dulce." Dr. Palmer reports that it is made into sweetmeats and the juice is put into "attole." The ripened fruit does not keep well, but when scalded or boiled for a short time it may be dried and then kept for a long time. The dried fruit is thus found in the markets long after the fruiting season is over.

A cooling drink is sometimes made out of the dried fruit, or it may be ground into "alote."

While the ciruela is a popular fruit in the Tropics and is especially suited to a dry country, yet the very large stone or nut which it contains is much against it. Doubtless little effort has been made to select the best varieties. The trees grow with so little care that the tendency seems to be to let them develop as they please. Orchards are planted by simply breaking off limbs and putting them into the ground, then allowing them to shift for themselves. If an experienced horticulturist should take hold of this fruit he would probably be able not only to reduce the size of the stone, but to increase the pulp, and thus add much to its value.

It is usually considered that there are but two varieties of the ciruela cultivated in Mexico. These are the yellow and the red, called, respectively, ciruela amarilla and ciruela roja (Pl. XXIX). In the part of the country visited I found four very distinct varieties, or rather species, in cultivation and one wild species, making five in all.

Mr. Hemsley, in the Biologia Centrali-Americana, lists five species, all of them coming, however, from south Mexico and only one named specifically, viz, *Spondias lutea*. The yellow and red forms mentioned



CIRUELAS—FRUIT OF SPONDIAS spp

above are referred to in Mexican works as *S. lutea* and *S. purpurea*, but they probably represent more than two species, if, indeed, these species are found in Mexico at all. In 1887 Dr. S. Watson described from Tequila, State of Jalisco, a yellow-fruited form under the name of *S. mexicana*, which appears to be the "ciruela amarilla," cultivated and sold on the west coast as far north as Guaymas.

The red-fruited form, which I saw only on the west coast, does not answer the description of *S. purpurea*, nor are the specimens like those so named in the National Herbarium.

The five forms obtained by me may be described briefly as follows:

1. *Yellow ciruela.*—Fruit spherical, 2.5 to 3.1 cm. (1 to 1¼ inches) in diameter, of light yellow color; surface of nut strongly roughened with a kind of filigree work.

2. *Red ciruela.*—Fruit similar to the above, but perhaps smaller and red in color. Trees said to be taller and less spreading.

3. *Wild ciruela.*—Fruit much smaller than the two preceding, red in color, the leaves of very different shape and size; a small shrub or bush 0.6 to 1.2 meters (2 to 4 feet) high. Found on low hills near Acaponeta.

4. *Ciruela* (from State of Jalisco).—A tree similar to the common yellow ciruela, but with very pubescent leaves; fruit yellow, about 2.5 cm. (1 inch) in diameter; nut with smooth surface. Only seen once, in the State of Jalisco. The fruit is said not to be edible.

5. *Ciruela* (from City of Mexico).—This was the largest plum seen. Fruit oblong to obovate, 4.4 cm. (1¾ inches) long, yellowish with a pronounced blush; nuts large, not so much roughened as in the common yellow-fruited form. I did not see the trees or foliage. I was told at the National Museum of Mexico that this was true *Spondias lutea*.

EXPLANATION OF PLATE XXIX.—Fig. 1, yellow ciruela, dried; fig. 2, the same, fresh; fig. 3, seed of same; figs 4 5, dried fruit and seed of a wild species; fig. 6, seeds of the cultivated red variety; figs. 7, 8, fruit and seeds of a large yellow variety; figs. 9, 10, fruit and seeds of a wild variety.

I collected considerable material, but, as was usually the case, not as much as would be desirable. Besides the herbarium specimens the following material was obtained:[1]

EB No. 108. One fruit in alcohol, of common yellow ciruela, from Mazatlan, June 18, 1897.
EB No. 109. Nuts of same from Acaponeta, June, 1897.
EB No. 110. Dry fruit of red ciruela from Acaponeta, June, 1897.
EB No. 111. Nuts of same.
Herb. No. 3076. Two fruits in formalin of ciruela from State of Jalisco.
Herb. No. 3076. Nuts of the same.
EB No. 112. The dried fruit as sold at Guadalajara, probably of the yellow form.
EB No. 113. Two fruits in formalin of the larger ciruela purchased on the streets in the city of Mexico.
EB No. 115. Nuts of the same.

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[1] The symbol EB denotes the Ethnobotanic collections of the author.

The following names are used for these fruits:

Ciruela.—A generic name applied to all plumlike fruits, but especially to the species of Spondias. It is often used for the various kinds without a qualifying term.

Ciruela amarilla.—Usually applied to the fruit of *S. lutea*, but also given to any of the yellow kinds.

Ciruela roja.—Supposed to belong to *S. purpurea*, but probably used for any of the red fruits.

Ciruela campechana.—Cuban name for the fruit of *S. purpurea*.

Ciruela colorada.—Another Cuban name for the same.

Jabo.—The Cuban name for *S. lutea*.

CACTACEAE.

The Cactaceae furnish a great variety of fruits, many of which are highly prized in Mexico. These come from various species of Opuntia and Cereus and of some other genera.

Opuntia spp. TUNA.

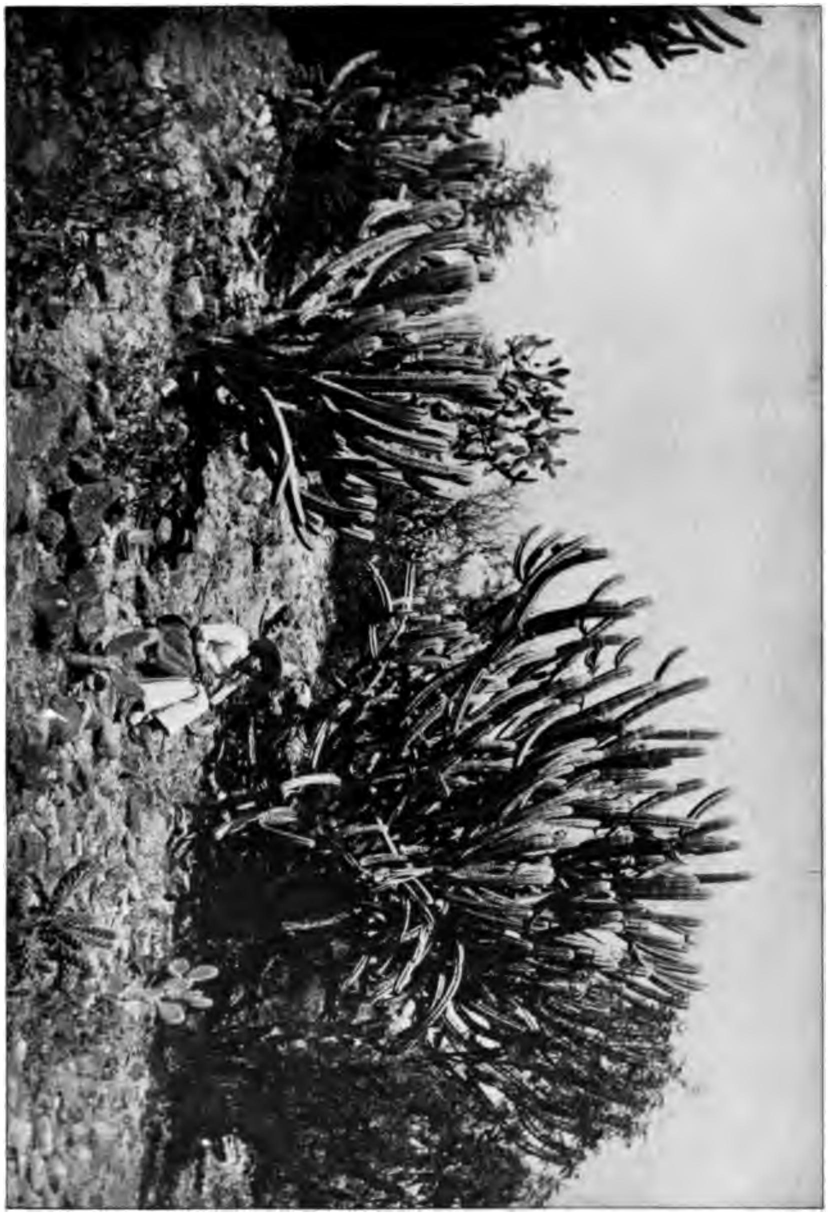
Quite a number of Opuntias furnish choice fruits, all known by the name of "tuna." The species which are said to furnish the tunas are generally given as *O. tuna* and *O. ficus-indica*, but it is not at all certain that these are the ones which furnish the best tunas of Mexico. Both of these species are said to be introduced into the Old World, but the fruit sent to this country from Italy appears to be different from the common tunas of Mexico. The whole subject should be taken up by some botanist who has access to large collections, after having made extensive field collections of fruits, flowers, and stems, and having secured numerous photographs. In the markets at Mazatlan, on the west coast, I found a small, deep red colored tuna, perhaps 2.5 cm. (1 inch) long, to be very common. The large tunas were not met with until I reached the Sierra Madre. These were very common at Santa Teresa, Tepic, altitude 2,040 meters (6,800 feet), and at most of the towns at which I stopped in the table-land region of Zacatecas and Jalisco. One of the best and largest of these tunas is the "crystalina." This is one of the most delicious fruits I met with in Mexico, and ought to be introduced into the United States. Plants that grow in Mexico at an altitude of 1,500 to 2,100 meters (5,000 to 7,000 feet) could be easily grown in parts of Arizona and New Mexico.

Cereus geometrizans Mart. GARAMBULLO.

This is a common species on the table-lands of western Mexico. The fruit, which is a small, oblong berry about 1 cm. (⅖ inch) long, is said to be very common in the markets during its season, which must be after the close of the rainy season. At the time of my visit, about the 1st of September, I found the fruit nearly ripe. (Pl. XXX.)

Cereus spp. PITAYA, PITAHAYA.

The pitaya is said by some to be the fruit of *C. variabilis* and by others to be that of *C. pitahaya*. The name is also applied to the fruit of *C. thurberi*, *C. giganteus*, etc., and "pitahaya" is probably better con-



GARAMBULLO (CEREUS GEOMETRIZANS Mart).

sidered as a generic term applied to the edible fruits of several species of Cereus, whence the terms "pitahaya dulce," "pitahaya acre," etc. I did not see any of these fruits, but the plant which was pointed out as the pitahaya of central Mexico was a very large species, 7.5 to 10.5 meters (25 to 35 feet) high, somewhat resembling *C. pecten-aboriginum*, but probably referable to *C. tetazo*.

Tomales are made out of the dried fruit of one or more pitahayas. For drying, the inner part of the fruit is taken out and allowed to lie in the sun for several days. It is said to be very sweet and will keep for a year.

MYRTACEAE.

Myrtus arayan H. B. K. ARRAYAN.

I saw this tree only about Indian villages in the foothills of the Sierra Madre. The tree here grows to be 6 to 10.5 meters (20 to 35 feet) high, the trunk 4 meters (12 feet) high, and sometimes 36 cm. (15 inches) in diameter, with smooth, gray bark and erect branches. In no place did it appear to be native, but it seems to be cultivated somewhat extensively in Mexico. It is grown in sufficient quantities in some twelve States to be listed among their fruits, and the annual crop is valued at over $1,200. The ripe fruit is sold in the fresh state in all the larger markets, and, according to Dr. Palmer, also in the dried state. I obtained some of the ripe fruit at Guadalajara. It was greenish yellow, 1.25 to 1.87 cm. (½ to ¾ inch) in diameter, smooth, with a large, irregular disk at the top and a smooth nutlet in the center; very juicy, and said to have a rich, spicy, subacid flavor.

One of the popular "soft" drinks of the country, which is said to be very refreshing, is made from these fruits.

The following specimens were obtained:

EB No. 105. Fruit in formalin, obtained at Guadalajara, September, 1897.

Herb. No. 2006. Specimens from a tree seen in the Indian village of San Blascito, Tepic, August 4, 1897.

Psidium spp. GUAYABA.

Guavas, or "guayabas," as they are called in Mexico, are common along the coast and in the hot valleys of the interior. I saw four species, two of which are wild. *Psidium guava* appears to be the one commonly cultivated. It is usually a small tree, 3 to 4.5 meters (10 to 15 feet) high, often with a large top. The fruit is used everywhere. It is often eaten raw, but generally made into preserves, jams, and jellies.

COMBRETACEAE.

Terminalia catappa L. ALMENDRA.

I saw this tree only in the town of Rosario and at La Paz, Lower California, where it was cultivated. Dr. Palmer states that the nuts are known as "almendras" or Mexican almonds. He says the children eat the outer pulpy husk. The fruit, which is a drupe, is much flattened, elliptical, and about 2 inches long. The stone contains a small, sweet and edible seed. Dr. Palmer states that the tree is also called "story tree," because the horizontal branches are given off in whorls or "stories." These trees seem to be frequent in the towns of western Mexico and furnish one of the few shade trees there, growing to the height of 10.5 to 12 meters (35 to 40 feet). It is now frequently met with in Guatemala and south Florida. The tree is native of tropical Asia.

SAPOTACEAE.

Achras sapota L. ZAPOTE CHICO.

This is a common tree in cultivation. Some large trees were seen at Acaponeta, perhaps 40 to 50 feet high. The fruit is nearly orbicular in outline, 2.5 to 3.75 cm. (1 to 1½ inches) in diameter, with a rough, brownish skin. It is sold in the markets in June and July. The annual crop is valued at $38,000.

This is said to be the tree which produces most of the "chicle," a gum extensively imported into the United States, and used in the manufacture of chewing gum, which is almost wholly composed of it. It is said that *Vitellaria mammosa* (L.) Radlk. as well as other species of the genus *Vitellaria* produce chicle, and that the best gum for "masticatory" purposes is that obtained from *V. mammosa.*

According to Treasury reports for 1897, 5,315,902 pounds of this gum, valued at $1,091,892, was imported into the United States in the year 1896–97. The crop for 1897–98 is estimated at only 2,600,000 pounds. Under the Wilson bill the gum was admitted free of duty but now there is a duty of 10 cents per pound.

The following tables will show the quantities of chicle gum received at New York in 1897 and 1898 from several ports:

Comparison of monthly and annual receipts of chicle gum at New York, months of January, 1897 and 1898, and years of 1897 and 1898.

From—	Jan., 1898.	Jan., 1897.	Sept. 1, 1897, to Sept. 1, 1898.	Sept. 1, 1896, to Sept. 1, 1897.
	Bales.	*Bales.*	*Pounds.*	*Pounds.*
Tuxpan	544	887	304,000	552,000
Vera Cruz	11	309	29,000	114,000
Campeche	....	150	40,000	117,000
Laguna	259	797	114,000	183,000
Progreso	998	1,228	332,000	562,000
Belize	256	490	76,000	174,000
Various	79	15	39,000	24,000
Total	2,147	3,876	934,000	1,696,000
Or pounds	335,000	608,000		

Comparison of stock on hand for two years.

	Pounds.
February 1, 1898:	
Free	539,000
In bond	397,000
February 1, 1897	886,000

Comparison of prices.

	Cents.
Lowest price;	
January 5, 1898	27½
January 29, 1897	21
Highest price:	
January 31, 1898	29
January 4, 1897	23

EBENACEAE.

Diospyros ebenaster Retz. ZAPOTE PRIETO.

The fruit is also called "zapote negro." The annual crop is valued at $27,000. I did not see the fruit of this plant either used or sold, although it is said to be cultivated in many places. Fruiting specimens of a species probably the above were obtained at Acaponeta at an altitude of about 30 meters (100 feet). It has heretofore been reported to grow at an altitude of 450 to 1,800 meters (1,500 to 6,000 feet), and it is not at all unlikely that more than one species goes under this name. Two other specimens were collected—one at Altata (at sea level) and the other at Colomas, altitude 750 meters (2,500 feet), which seem to represent two very distinct species.

VERBENACEAE.

Vitex mollis H. B. K. UVALAMA.

Uvalama, or better, perhaps, walama, is a small drupe which is very common in the markets of the west coast at the close of the dry season. The fruit is black or bluish black, nearly spherical, and 15 to 20 mm. in diameter. It is eaten raw. (EB Nos. 112 and 113.)

CUCURBITACEAE.

Cucurbita ficifolia Bouché. CHILACAYOTE.

The pulp of this fruit is boiled with sugar and used as a dessert. I was told that the fruit is about 0.45 meters (1½ feet) long, with a hard shell and a fibrous pulp. The seeds are black, resembling those of the watermelon, but larger. The fruit is cut in two and the pulp is taken out and cooked. The shell is filled with water and allowed to stand and sour. From this a vinegar is made which the people use in making a kind of soda water.

BEVERAGE PLANTS.

The drinks of Mexico derived from plants are of the intoxicating and the nonintoxicating classes.

Agave spp. MAGUEY.

The intoxicating drinks are several, but the most important by far are those made from the agave plants or magueys. Of these drinks there are two classes, the fermented and the distilled. The fermented drink is called pulque. It is largely used all over the country and especially about the City of Mexico. The pulque plant (Pls. XXXI to XXXIII) is cultivated throughout the mountain regions and on the table-lands. Almost every house has a few plants growing near it which supply pulque for the family.

The pulque magueys are several in number. They all have large, broad, thick leaves and belong to the Euagave section of the genus. A large cavity or bowl is hollowed out of the center of the plant by taking out the bud or core, and into this sap from the cut leaves oozes. The accumulation is gathered twice a day, as sugar water is in our maple orchards. This sap when fermented forms the pulque. Each day the surface of the bowl is scraped to increase the flow and this is kept up for several weeks. It is customary to bend over and fasten together the leaves of the agave plant at the top to retard evaporation.

The distilled drink called mescal, or now perhaps more commonly tequila, is made from what are called the mescal magueys These have much thinner leaves than the pulque magueys and, in the case of the species so largely used in the manufacture of tequila, the leaf is very narrow. The Indians and Mexicans of the mountainous regions use a number of the wild species for making their mescal. The tequila maguey, however, is cultivated in great plantations. I have not been able to learn what the species is which goes under this name. At Bolaños there is cultivated under the name of the "huila" what is perhaps the same species.

One of the most interesting studies connected with the botany of Mexico would be the determining of the species of Agave which are used by the people in making their drinks—a subject upon which there is much ignorance.

Carl Lumholtz, the well-known Mexican traveler, states that "the Mexicans derive their famous tequila or mescal from the maguey (*Agave americana*). One of the inferior kinds of brandy, sotol, is produced from a plant of the same family." While it is uncertain from what species tequila is made, it is at any rate not *A. americana*, and sotol, as we shall see, is derived from plants of another genus.

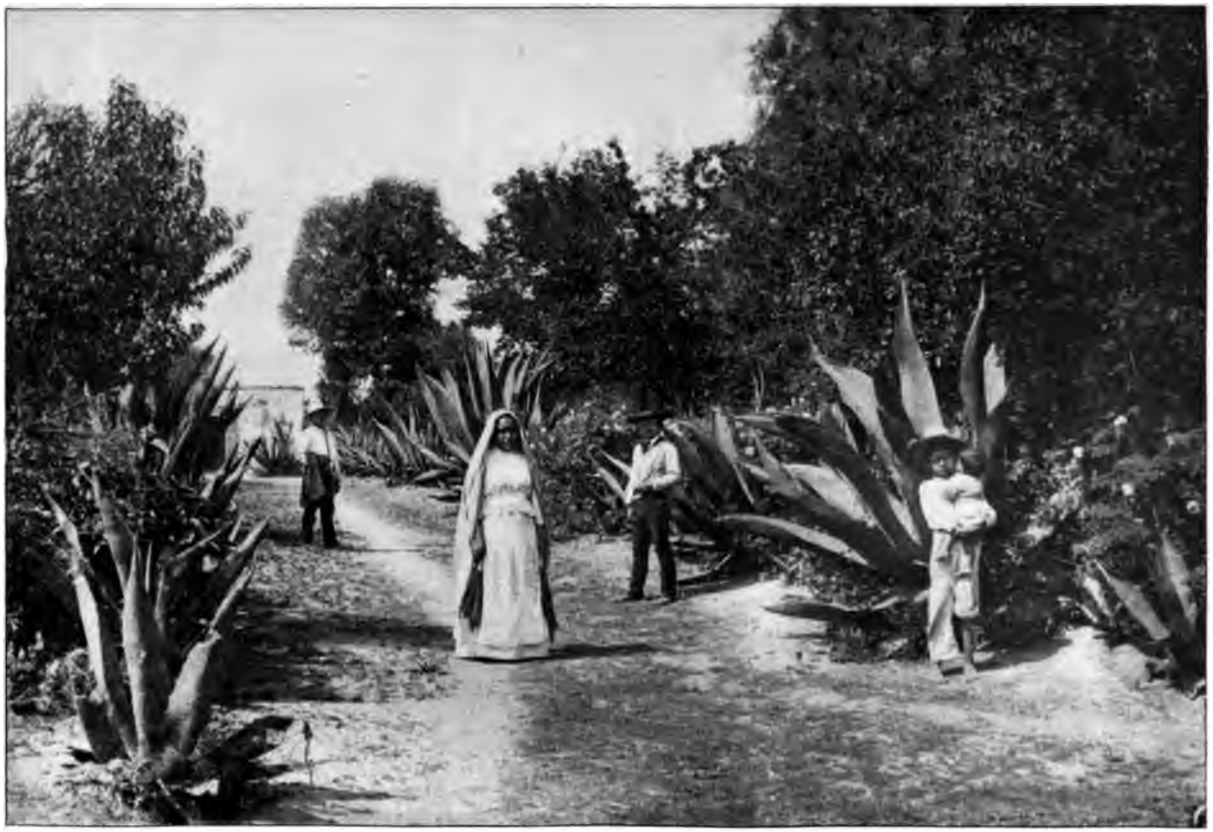
Dasylirion spp. **SOTOL.**

Sotol, a common distilled drink of the table-land region, is made from the species of Dasylirion, the crown of the plant being utilized. The drink is similar to mescal and is often mixed with it. (EB No. 43, a bottle of sotol liquor.)

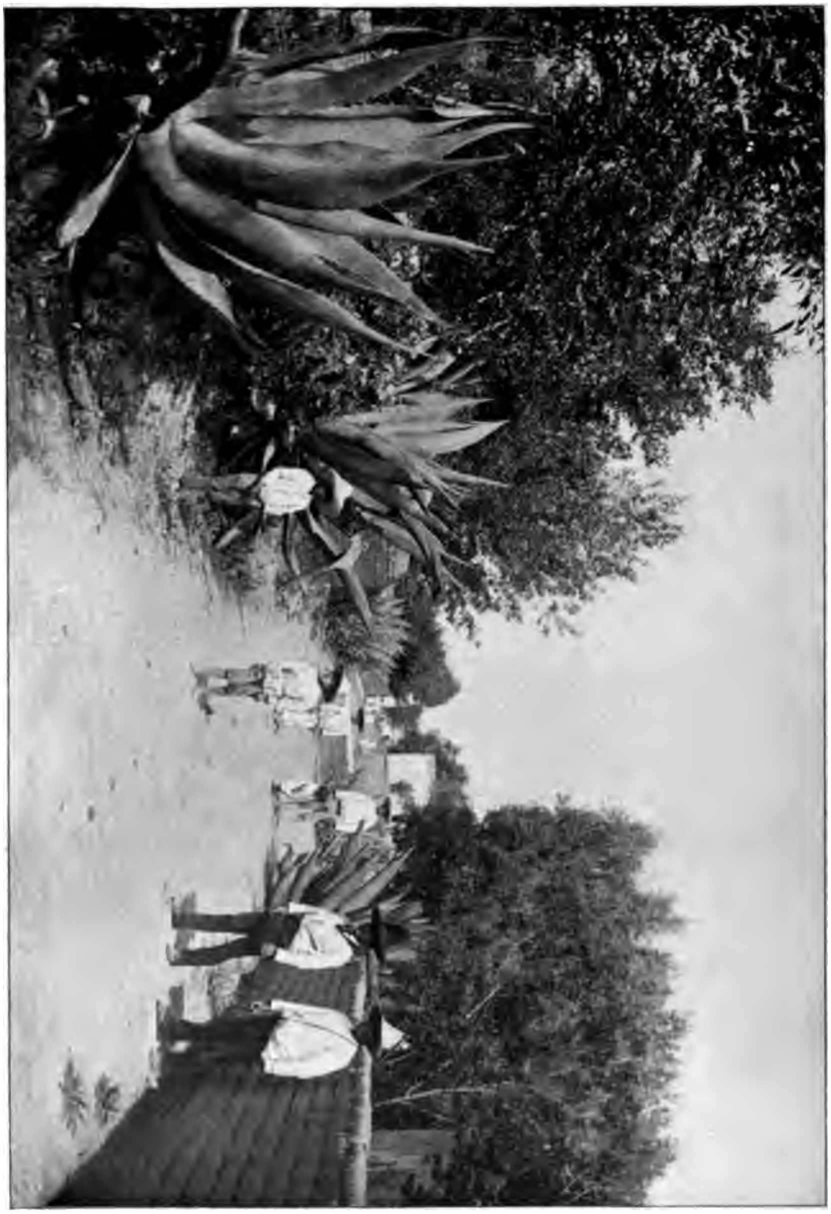
Aguardiente, made from cane sugar, is also one of the chief distilled drinks of the country.

The nonintoxicating drinks of the country are very many. They are usually made of some acid fruit, such as limes, tamarinds, etc., or of mucilaginous seeds, such as those of certain mustards and mints. I shall not attempt to enumerate all of them, but wish to refer briefly to the few which came under my observation.

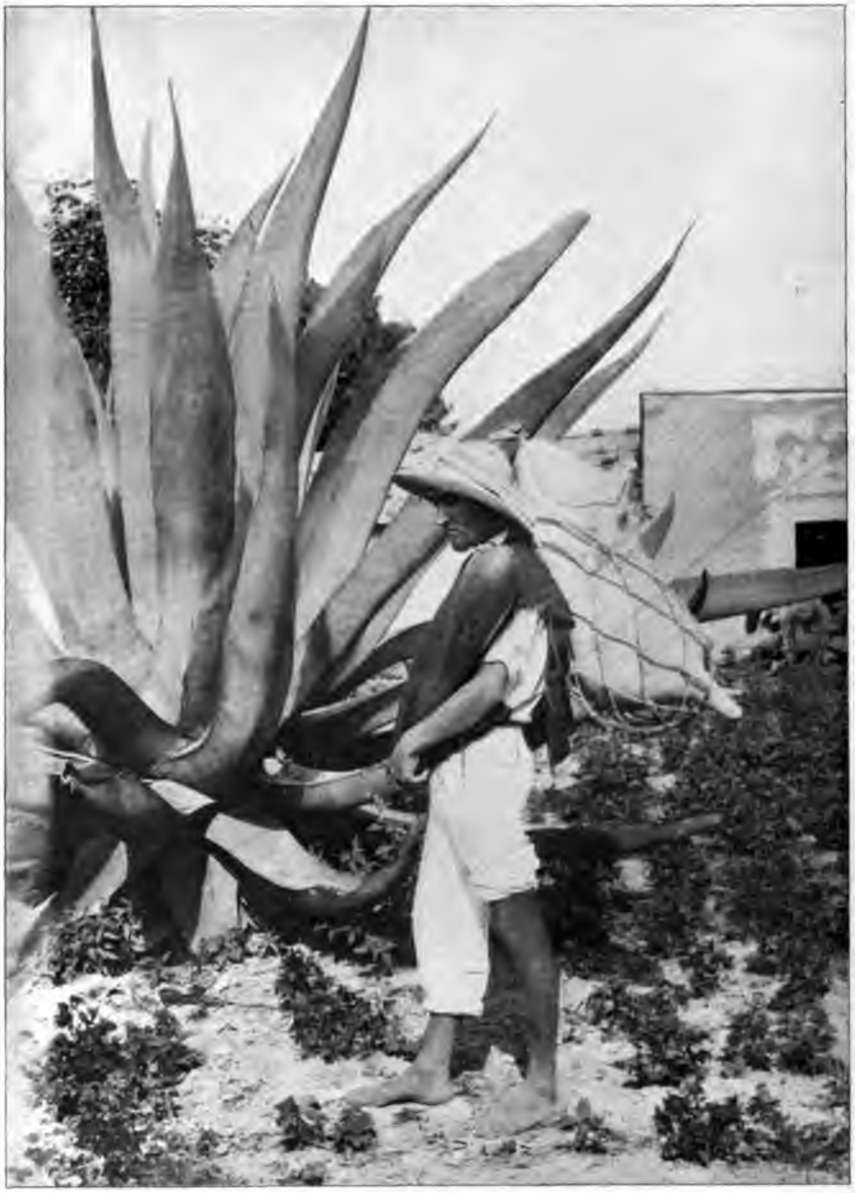
Some of these drinks are peddled about the streets carried in "olla" on the top of men's heads. and some are for sale in the markets or at the hotel bars, etc. Women have regular stands for selling them in the arcades about the public squares of most large towns and in market buildings.



PULQUE PLANT OR MAGUEY (AGAVE ATROVIRENS Karw.).



Pulque Plant or Maguey (Agave atrovirens Karw.).



PULQUE PLANT OR MAGUEY (AGAVE ATROVIRENS Karw.)

Hibiscus sabdariffa L. JAMAICA.

One of the most popular of the summer drinks of Mexico is made from "jamaica." Jamaica is made from the involucres, calyces, and capsules of *Hibiscus sabdariffa* which have been gathered and dried. The jamaica gives to the water a reddish color and a slightly acid taste. In the markets at Guadalajara it is seen packed in large shallow baskets where it is retailed.

Sisymbrium canescens Nutt. PAMITA.

From pamita the seeds of *Sisymbrium canescens*, a most refreshing drink, is prepared in the following manner: About a gill of the seed is put into a glass and thoroughly mixed with water; a little lime juice is then added and the mixture again stirred, then a little sirup, then a little blackberry brandy or claret, the stirring process being repeated as each new ingredient is added, until finally the glass is filled with water, when it is ready for drinking. A straw is generally used in drinking this mixture. *Sisymbrium canescens* is very common in Sonora. The seed is collected in great quantities about Altar and is sold at Guaymas. These seeds, when wet, give off a great quantity of some mucilaginous substance.

Salvia spp. CHIA.

The well-known drink made from chia, the seeds of species of Salvia and related genera, is sold all over the country. At Guadalajara the seed is mixed with barley water. I obtained specimens at Colomas (EB No. 111).

Chia seed has been obtained from various markets in Mexico, and plants have been grown in Washington from which herbarium specimens have been made. These specimens have been determined by Mr. M. L. Fernald, who reports that the Salvias are *S. hispanica* L. and *S. tiliaefolia* Vahl. Seed and specimens of *chia grande* sent in by Dr. E. Palmer prove to be *Mesosphaerum suaveolens.*

Tamarindus indica L.

The tamarind tree (*Tamarindus indica*) is now grown all over tropical Mexico. The fruit is largely used in making a cooling drink, and is sold everywhere. At Guadalajara it is displayed in great shallow baskets 9 dm. (3 feet) in diameter and 20 cm. (8 inches) deep. (Pl. XXVIII, fig. 1.)

The fruit of two species of Bromelia is often used in making a subacid drink.

A drink is sometimes made of the dried fruit of the ciruelo[1] (*Spondias lutea*), while in many places the ripe fruit of arrayan[2] (*Myrtus arayan*) is used in the same way.

In Guadalajara I saw a drink called "tehuino," which is said to be made from cooked corn.

A drink called "agua de cebada" is made by adding to water barley flour, or more commonly softened barley ground on a "metate," together with sugar, cinnamon bark, and "ajonjoli," i. e. sesame, the seed of *Sesamum indicum* L.

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[1] See p. 217.

[2] See p. 221.

This mixture is of a muddy gray color, with a sweetish, starchy taste. It is carried about the streets in earthen jars and sold for 1 cent a glass.

SEASONING AND FLAVORING PLANTS.

Some very curious dishes are served. Roast beef is eaten with a dressing of squashes, onions, and oil, while beefsteak is sometimes dressed with a mixture of red peppers, onions, and whole potatoes the size of cherries. Aguacate salad is made of mashed aguacate, onions, and cheese, while a "tomale" which I dissected was found to be made up of a combination of chicken, onion, red peppers, olives, and raisins. At Guaymas red peppers stuffed with cheese were served. Another interesting preparation called "enchalada" is made out of chile colorado, queso (cheese), and cebollos (onions) folded up in a tortilla. These are mentioned not because they are peculiar, but as samples of scores of others.

LAURACEAE.

Litsea glaucescens H. B. K. var. LAUREL.

The leaves of this plant are much used in flavoring meats, soups, etc. It can be found in the little stores and markets everywhere. It is also considered to have some medicinal virtues. The leafy branches are gathered in bundles and dried. The crushed leaves are very fragrant and aromatic. It is a small glabrous shrub with narrow lanceolate leaves, pale green above, whitish beneath, and thickly covered with small pellucid dots. It grows high upon the mountains. Specimens were collected in the mountains near the Indian village of Santa Teresa, Territorio de Tepic, and near Plateado, in the State of Zacatecas, while dried specimens were bought at Bolaños.

UMBELLIFERAE.

Carum petroselinum Benth. PERIJIL.

Cultivated in gardens, and used in flavoring all kinds of dishes.

Coriandrum sativum L.

Commonly used as a flavoring for soups, etc. It is largely sold in the markets, usually with cabbage and squash, small pieces of these and a stem of coriander being frequently seen laid out together, ready for purchasers.

VERBENACEAE.

Lippia spp. OREGANO.[1]

The leaves of oregano are very much used to flavor food. Dr. Palmer states that at Acapulco they are used much as we use sage. It is cooked with fish, sausage, and other foods.

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[1] Also spelled oregeno, oragano.

The name "oregano" seems to be a generic term applied to the leaves thus used of several species of Lippia. The plant so called at Acapulco is *L. berlandieri* Schauer; in Lower California, *L. palmeri spicata* Rose, while on the table-land I found it to be *L. purpurea* Jacq.

SOLANACEAE.

Solanum tuberosum. PAPA.

Strange as it may seem the potato, as used in Mexico, is to be classed as a flavoring rather than as a vegetable. I never saw the potato there used as we use it. A few only, and these whole and very small, are added to soups and stews, along with raisins, olives, nanches, etc. Most that I saw were from about the size of cherries up to the size of small walnuts. The potatoes which they have are either the wild potatoes from the mountains or those which have recently been transplanted thence. The wild potato is apparently common. I collected specimens in the foothills, near Colomas, at an altitude of 840 meters (2,800 feet), and on the top of the Sierra Madre, altitude 2,040 meters (6,800 feet).

Sweet potatoes, on the other hand, often reach a good size. These are cooked and brought to the markets in great quantities, and sold on the plaza and along the sidewalks.

EUPHORBIACEAE.

Argithamnia sp. AZAFRAN.

A kind of seed used in giving an orange color to soups, etc.

MEDICINAL PLANTS.

The native plants used as medicines, or supposed to have medicinal properties, are legion. Many of these, doubtless, have little or no real value.

The country people and Indians seem to have but little knowledge of medicine, generally using teas made of bitter and strong-smelling herbs.

More or less superstition is associated with certain plants, and great stress is laid upon some superstitious practices, for instance, that of sticking certain seeds on the temples to cure headache.

Along the coast, Indian peddlers bring down from the mountains various seeds or dried herbs to sell, or these may be found in the little stores of the towns. Sometimes on the plaza one finds the "herb doctor" dealing out a paltry stock of medicines in cent packages.

Much of the material which I saw for sale was in the form of dried roots or leaves, and in such cases specimens were not taken unless I saw the material collected and could identify the plant botanically.

The uses of these plants as given below are as they were told me.

FILICES.

Adiantum capillus-veneris L. CELANTILLO DE OJO DE AGUA.

At Colomas this plant is used as a tea to relieve colic, but at Colotlan is taken as a tea for amenorrhea. This furnishes a good example of the diverse uses plants are often put to. The dried fronds were for sale in the plaza at Colotlan (EB No. 29).

Polypodium lanceolatum L. LENGUA DE CERVO.

A tea made from the fronds of this fern is taken to cure the itch. The dried fronds were for sale in the plaza at Colotlan (EB No. 27).

LILIACEAE.

Aloe sp. SAVILA.

The crushed leaves of this plant are used with oil in making a poultice to reduce swellings caused by venereal diseases. The plant was only seen about houses and towns where it had apparently been planted. My specimens came from La Paz (Herb. No. 1303).

CHENOPODIACEAE.

Chenopodium incisum (L.) Poir. IPAZOTE DEL ZORILLO.

The skunk ipazote is a general medicine in use among the common people and supposed to have various virtues, being usually taken in the form of a tea, which is reported to cure colic, pneumonia, etc. (Herb. No. 3610 and EB No. 28.) My specimens were bought on the plaza at Colotlan, September, 1897.

MAGNOLIACEAE.

Magnolia sp. CORPUS.

From the flowers a tea is made which is used to cure scorpion bites. The flowers are brought from trees which grow in the western foothills at an altitude of 3,000 to 3,500 feet.

ANONACEAE.

Anona sp.

The bark of this plant is boiled in urine and used to kill the mange on all kinds of animals. (Herb. No. 1681.)

LAURACEAE.

Litsea glaucescens H. B. K. var. LAUREL.

A tea made from the leaves of laurel is taken for colds. The plant is, however, more largely used as a flavoring. (Herb. No. 3436 and EB No. 63.)

LEGUMINOSAE.

Enterolobium cyclocarpum Griseb. HUINECASTLE.

A sweet sirup is made from the bark of this tree, which is used in cases of colds, etc.

The bark is also used as a soap and in tanning. My specimen came from Colomas (Herb. No. 1759).

Leucaena sp. TEPAHUAJE.

The country people use the bark to harden their gums. My herbarium specimen was obtained at Colomas, July, 1896 (Herb. No. 1725. EB No. 124, pieces of bark as used by the people at Colomas.)

ZYGOPHYLLACEAE.

Covillea tridentata (DC.) Vail. GOBERNADORA.

A sample of this plant, as sold at Acaponeta, was purchased of an Indian peddler at that place.

A tea made out of the leaves and branches is taken by women for pains in the womb, or the material, when fried in tallow, is used for rheumatism.

The specimen is said to have come from the mountains east of Acaponeta, but I saw no plants of it. (EB No. 76.)

MELIACEAE.

Swietenia humilis (?) Zucc. FLOR DE VENODILLO.

The seeds of the "flor de venodillo," which means "little-deer flower," are made into a tea which is taken for pains in the chest. Seeds were being sold at Acaponeta by Indian peddlers, who stated that they came from the coast near Acaponeta. (EB No. 77, seeds as sold by peddlers.)

EUPHORBIACEAE.

Acalypha phleoides (?) Cav. YERBA DEL CANCER.

The leaves and stems of this plant are made up into small bundles and dried. The leaves and flowers are crushed into a powder and applied to sores, etc. A tea is made from it and taken to cure itch. My specimens were purchased on the plaza at Colotlan, September, 1897. (EB No. 26.)

Euphorbia sp. YERBA DE COYOTE.

A tea is made from the dried plant which is supposed to relieve rheumatic pains. My specimen was purchased on the plaza at Colotlan, September, 1897. (EB No. 25.)

Euphorbia sp. YERBA DE GOLONDRINA.

This plant is a small Euphorbia said to have come from the high mountains east of Acaponeta. (Herb. No. 1520 and EB No. 122.)

It is boiled and used as a poultice to reduce swellings and cure sores.

Jatropha curcas L. SANGRE GRADO.

The plant is found in great quantities about fields. It is said to be used as a purgative, the seeds (physic nuts) being doubtless, as elsewhere, the part used.

RHAMNACEAE.

Karwinskia humboldtiana Zucc. MARGARITA.

The leaves of this plant are crushed and soaked in water and the cold infusion used in cases of fevers. It has a wide use in Mexico. My botanical specimens came from Colomas, but the plant has a wide distribution. (Herb. No. 3264.)

MALVACEAE.

Anoda hastata Cav. ALTEA.

The leaves of this plant mixed with olive oil are taken for inflammation of the stomach. My specimens came from near Plateado, August 31, 1897. (Herb. No. 2709.)

TURNERACEAE.

Turnera humifusa (Presl) Endlich. DAMIANA.

As is well known this plant is widely used in Mexico. At Acaponeta I obtained medical specimens which had been brought from La Noria, above Mazatlan. It is here used as a tea, and taken to relieve pains in the stomach and bowels. My specimens were purchased of Indian peddlers at Acaponeta, August 2, 1897. (EB No. 120.)

POLEMONIACEAE.

Loeselia coccinea Don. ESPINOCILLA.

The specimens were purchased at Acaponeta, and were said to have come from the mountains east of Acaponeta. From the leaves and stems an infusion or tea is made, which is taken to stop fevers. (EB No. 121.)

Loeselia sp. HINSESELI.

A tea is made of the leaves, which is used in fever and ague, while a cold infusion is used as a purgative.

VERBENACEAE.

Lantana sp. MAJORANA.

This is said to be much used to relieve indigestion. My specimen came from Plateado, September, 1897. (EB No. 119.)

Lantana sp. SONORITA.

The leaves of this plant, when boiled with barley, are given to women in childbirth.

LABIATAE.

Marrubium vulgare L. MARRUBIO.

A preparation made from the leaves of this is used for rheumatism. It is also added to mescal and applied as liniment for rheumatism. My specimens (EB No. 116) came from Plateado.

SOLANACEAE.

Datura tatula L. TOLOACHI.

This plant is reputed to have many medicinal virtues.

An unguent is made from the leaves by boiling the juice of the crushed leaves with tobacco and lard. The seeds are ground and used in the same way.

My specimen was obtained at Plateado, where the species grows common in waste places about houses. Collected September 2, 1897. (Herb. No. 2775; EB No. 37.)

BIGNONIACEAE.

Pithecoctenium sp. BEJUCO DE HUICO.

The large, winged seeds of this plant are applied to the temples, and are supposed to cure headaches.

The same use is made of rose leaves and also of a paste made from the vanilla bean. My specimens came from Colomas, July, 1897. (Herb. No. 1696; EB No. 123.)

COMPOSITAE.

Hieracium sp. LECHUGUILLA.

Small bundles of the green plant are for sale in the markets. From it is made an infusion which is used as a wash for sores and skin diseases. It is also applied as a powder. My specimens were obtained in the market at Colotlan, September, 1897. (Herb. No. 2680; EB No. 30.)

Piqueria trinervia Cav. ? TABARDILLO.

The crushed leaves are made into an infusion and taken as a remedy for typhoid fever. It is also said to be used to relieve deafness caused by typhoid fever. My specimens came from Plateado. (EB No. 118.)

Tagetes lucida Cav. YERBA NIL.

This is one of the most widely used medicinal plants of western Mexico. The species has a wide distribution. The plants gathered by the country people are made up into small bundles and dried, and then put away for use. It is made into a tea, and is supposed to have numerous virtues, including efficacy against scorpion bites, fever and ague, etc.

Dr. Palmer says that at Colima it is made into an insect powder. This is the same plant as the "Santa Maria" of the Cora Indians. My specimens were obtained at Colotlan and Plateado, September, 1897. (EB Nos. 24, 117.)

Zinnia linearis Benth. YERBA DE TORRO.

This plant is very common on the table-lands in Jalisco. The plants are broken off or pulled up by the roots and dried in small bundles, in which state they may be seen on the walls of the Mexican's hut. A tea is made from these dry stems, which is taken for pains in the stomach. My specimens were bought at a small ranch, one day's journey south of Bolaños, September 20, 1897. (Herb. No. 3079; EB No. 78.)

—— —— MANZANILLA.

The leaves are made into a tea and taken with olive oil for colic. With alcohol added the tea is given for nervousness.

SOAP PLANTS.

The Mexican countryman uses many of the native plants either in the place of soap or in its manufacture. In the country certain roots, fruits, barks, etc., called "amole," are extensively used in the raw state.

These are either rubbed upon the garment or added to the wash water. Among these are the roots of various agaves, yuccas, etc., and several fruits, as that of the soap berry and of Zizyphus. Manufactured soap is now widely used, either imported from the United States or made in the country. For the domestic soaps oils are obtained from the seeds and fruits both of native and introduced plants, the most important being a palm oil much used on the west coast, castor oil, and cottonseed oil.

In the notes which follow I have included both the species which were collected by myself and those which have been sent in by our collectors, especially Dr. E. Palmer. In the list at the end are recorded all the species which have been reported as used for soap or in soap making.

PALMACEAE.

Attalea cohune Mart.? COQUITO.

A palm known to the trade as the coquito grows in abundance about Manzanillo and furnishes large quantities of oil, which is shipped to the larger towns along the coast and manufactured into soap. Sufficient material has not been seen positively to identify the species, but it seems best to refer it as above until it can be definitely named.

At a factory at Guaymas, I obtained a sample of soap and of the palm oil made from this nut. The oil comes from Manzanillo and San Blas, and is made from the nuts grown about Manzanillo and perhaps other places in south Mexico. About 100,000 pounds of this oil is used each year in the Guaymas factory. A consignment of 57,000 pounds had just been ordered from San Blas at the time of my visit. The oil has much the odor of olive oil, and is said to make a very fine laundry soap, especially valuable for washing flannels. The soap is first made into a large cake which weighs 2,000 pounds. The large cake is at last cut into small pieces of 3, 3½, 4, 5, 7, 8, and 10 ounces, and then boxed for shipment to various places along the coast. In the making of each cake 350 pounds of the oil is used and 800 pounds of tallow. If the soap has the merits claimed for it, soap makers in the United States will find it to their advantage to inquire into the question of a supply of the oil of this palm.

The following specimens were secured:

EB No. 128. Palm oil obtained at Guaymas.
EB No. 129. A piece of soap obtained at Guaymas.

LILIACEAE.

Yucca baccata Torr.

It probably will be a surprise to many to learn that amole soap is much used in the United States.

The large rootstocks of *Yucca baccata* have long been used at Peoria, Ill., in making a fine toilet soap. A thousand pounds of this plant is consumed each month by the Mexican Amole Soap Company, who obtain their supply from the Organ Mountains, near Las Cruces, N. Mex. This company manufactures some twenty different kinds of soap preparations.[1]

AMARYLLIDACEAE.

Agave heteracantha Zucc.

Dr. E. Palmer has recently (November, 1898) brought back a large quantity of the rootstock of an Agave, probably *A. heteracantha*, or a species very near it, which he says is largely sold in the market at Saltillo, Coahuila, for soap. These rootstocks, or bases of the stem, are about 7.5 cm. (3 inches) long, 3.8 to 5 cm. (1½ to 2 inches) in diameter, and are covered with black scales or leaf bases. These pieces are sold in the open markets at 6 or 8 for a cent, according to size. They are prepared for use much as are the other native amoles.

Agave lechuguilla Torr.

Agave lechuguilla is very common on the hills about El Paso, both in Texas and Mexico, where I obtained botanical specimens. Dr. Havard states that the leaves contain a valuable substitute for soap. (Herb. No. 1101.)

Agave variegata Jacobi.

Mr. Fred. Stark, of Brownsville, Tex., writes that the rootstock of this species is called "amole," and that a piece the size of a small walnut when "grated and mixed with a quart of warm water is enough to clean a full suit of clothes."

Agave sp.? AMOLE.

Dr. Palmer procured in the market at Guaymas specimens of another soap plant with leaves resembling those of *Agave angustissima* Engelm. As noted by him, it is found in the mountains near that place. The stems are cut off just above the ground and the leaf clusters, two tied up together, a smaller within a larger one, are brought to market to be sold as a substitute for soap. This material after being pounded is thrown into water to be used for washing blankets or woolen clothing.

Manfreda spp. AMOLE.

The herbaceous annual-leaved agaves (§ Manfreda of most authors) are called "amole" all over Mexico in contrast with the perennial-leaved ones (Agave proper), which are called "maguey." These are used as generic terms, and throughout my whole trip I did not find them used interchangeably. This is, I know, at variance with many printed statements. The species of the Manfreda group most generally used is supposed to be *Agave brachystachys*, sometimes called *A. saponaria* on account of its use as soap. I did not see this species in flower or even growing, but I brought back roots which are now in cultivation and will sooner or later flower. The roots were purchased in the markets where they were being sold under the name of amole. Specimens were obtained both at Bolaños and Guadalajara. At the former place I was told that the roots were used in every household of the town. The plants are said to grow high up in the Sierra Madre. They are brought down by the Huichole Indians, and this forms the principal occupation of many of them. The part of the plant which is used as soap is really not the root, but a thick, irregular rootstock sometimes forming large masses (Pl. XXXIV). The natives dry these rootstocks, and when grated and put into water they form a good lather.

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[1] For further notes on the use of this plant see Havard in Proceedings U. S. National Museum, vol. 8, p. 516, 1885.

The specimens obtained are:

EB No. 61. Amole. Bought in the market at Bolaños.
EB No. 72. Amole. Bought in the market at Guadalajara.

Specimens were purchased by Dr. Palmer in 1898 at Zacatecas of another amole which has a quite different rootstock from that of *A. brachystachys*, belonging perhaps to *A. guttata*. The rootstocks are always single, 5 to 6.25 cm. (2 to 2½ inches) long. Dr. Palmer states that a frequent way of preparing it, practiced by the Mexicans, is to mash or pound the rootstocks between stones, put the powder into a small quantity of water, and, after allowing it to soak, drain the water off into the wash water.

It is not at all unlikely that quite a number of the species of Manfreda are used as soap, but have not yet been reported. The roots which are sold in the markets are brought in by the Indians or country people without any vestige of foliage or flowers, and of course are not in condition for identification. These roots, however, are very tenacious of life and can be planted long after they have been taken from the ground. Dry rootstocks which I purchased in Mexico showed considerable vitality after sixteen months.

Prochnyanthes viridescens Wats. AMOLILLA.

"Amolilla" was the name given to me for *Prochnyanthes viridescens*, a common plant of the mountains with rootstocks very similar to those of the herbaceous Agaves and said to be used for soap in the same way. (Herb. Nos. 2045, 2679, 3724, etc.)

PIPERACEAE.

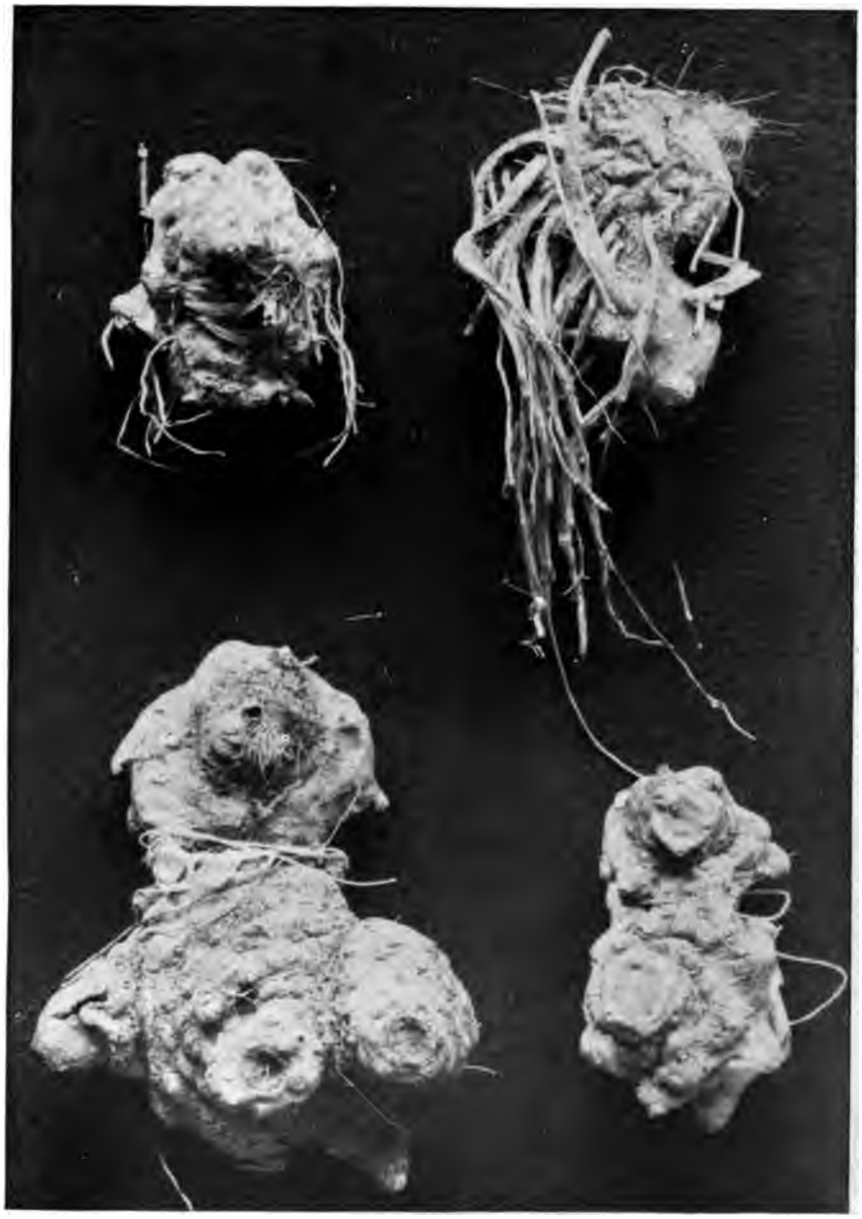
Piper palmeri C. DC. HACHOGUE.

This plant was collected by Dr. Palmer at Colima. He states that it is used by laundresses for cleaning clothes, and that the liquid obtained by boiling it is used to cure colic in man and in horses and mules, and for pains in the stomach and chest, also for cutaneous diseases. It is applied either externally or internally. The fruits, which resemble small candles, are edible.

PHYTOLACCACEAE.

Stegnosperma halimifolia Benth.

The powdered root of *Stegnosperma halimifolia* is used by the people of Lower California, according to Dr. E. Palmer, as a substitute for soap.



ROOTSTOCKS OF AN AGAVE (MANFREDA) USED FOR SOAP.

ROSACEAE.

Licania arborea Seem. CANA DULCE.

The seeds of a Licania (probably *L. arborea*) which grows about Acapulco are very rich in oil. According to Dr. E. Palmer the people at Acapulco make from them a vegetable tallow which is added to other oils in soap making. This tallow gives a green color to the soap. The plant grows in the lowland and on mountain sides about Acapulco, growing to the height of 4.5 to 6 meters (15 to 20 feet).

It is known under various names, such as cana dulce, cacahuate, cacahuianche.

LEGUMINOSAE.

Entada polystachya DC. BEJUCO DE AMOLE.

Dr. Palmer furnishes the following data:

"This is a vine, hanging for support upon other plants. Its numerous large seed pods flapping in the wind are a novel sight. It has curious hooks, by which it swings itself from tree to tree. The older wood of this plant is cut up into suitable lengths, then pounded with stones until the entire mass is separated into shred-like form, when it is tied into bundles and sold in the market to be used as a substitute for soap by the poor."

Specimens were collected by Dr. E. Palmer at Acapulco, 1894–95. (Herb. No. 159.)

Enterolobium cyclocarpum Griseb. HUINECASTLE.

The bark and pods of *Enterolobium cyclocarpum*, called "huinecastle," are used in place of soap for washing woolen clothes at Colomas, a little hamlet in southeastern Sinaloa.

EUPHORBIACEAE.

Ricinus communis L. HIGUERILLA.

The castor-oil bean is largely grown in Mexico. It there often assumes a tree-like form, reaching a height of 4.5 to 6 meters (15 to 20 feet). The seeds furnish much oil. I saw the plant only on the tablelands, but it seems to be common elsewhere. According to Dr. Palmer this oil is also used in soap making.

RHAMNACEAE.

Zizyphus mexicana Rose.

The fruits of *Zizyphus mexicana*, according to Dr. Palmer, are highly prized for washing woolen goods. He found them used in the State of Colima, where they are seen for sale in the markets.

MALVACEAE.

Gossypium sp.

Dr. Palmer states that much cotton-seed oil is used in soap making in the States of Durango and Coahuila. He does not know which species of Gossypium furnishes the seed, but it is probably *G. herbaceum*.

PEDALIACEAE.

Sesamum indicum L. AJONJOLI.

Sesamum indicum is cultivated at Acapulco and other places in Mexico. The seeds are very oily and are used in many ways in cooking, candies, etc. According to Dr. Palmer the oil is used in making soap. In Mexico this plant grows to the height of 0.9 to 1.2 meters (3 to 4 feet).

CUCURBITACEAE.

Cayaponia dubia (Hook. & Arn.) **Rose.**

Cayaponia dubia is a vine common on the west coast of Mexico. The vine, with the ripened or half-ripened fruit, is gathered and sold in the markets at Rosario and elsewhere. It is said to be used in the place of soap. The dry stems and fruit are crushed before using. (Herb. No. 1481; EB No. 81.)

Cucurbita foetidissima H. B. K. CALALEASILLA.

Dr. Palmer tells me that a Cucurbita (probably *C. foetidissima*) with small fruit is much used by the washerwomen in northern Mexico. He states that they mash the fruit and vines into a kind of pulp and add it to their wash water.

Dr. Manuel Urbina published a short paper on "Los Amoles Mexicanos," in 1897, in which he listed 21 species of plants used as amole.

In the list which follows 30 species are recorded. So far as known I have given the Mexican name and the part of the plant used.

Soap plants of Mexico.

Systematic name.	Common name.	Parts used.
RHAMNACEAE:		
Zizyphus mexicana Rose	Amole	Fruit.
SAPINDACEAE:		
Sapindus galeotti Gray		Fruit.
Sapindus inequalis DC		Do.
Sapindus marginatus Willd		Do.
Sapindus saponaria L		Fruit (?).
Sapindus sp		Fruit.
LEGUMINOSAE:		
Entada polystachya DC	Bejuco de amole	Wood.
Enterolobium cyclocarpum Griseb	Huinecastle	Bark and pods.
CUCURBITACEAE:		
Cayaponia dubia (Hook. & Arn.) Rose		Fruit and vine.
Cucurbita foetidissima H. B. K		Do.
PHYTOLACCACEAE:		
Phytolacca octandra L		
Phytolacca icosandra L		
Stegnosperma halimifolia Benth	Amole	Roots.
DIOSCOREACEAE:		
Dioscorea convolvulacea Cham. & Schlecht		
Dioscorea sp		
PIPERACEAE:		
Piper palmeri C. DC		

Soap plants of Mexico—Continued.

Systematic name.	Common name.	Parts used.
LILIACEAE:		
Yucca rupicola rigida Engelm		
Yucca baccata Nutt.	Amole	Roots and rootstocks.
Yucca angustifolia Pursh		
AMARYLLIDACEAE:		
(§ Agave proper.)		
Agave filifera Salm Dyck		
Agave heteracantha (?) Zucc		Rootstock.
Agave lechuguilla Torr		Leaves.
Agave mexicana Lam		
Agave parryi Engelm		
(§ Manfreda.)		
Agave brachystachys Cav	Amole, lechuguilla	Rootstock.
Agave guttata Jacobi & Bouché	do	Do.
Agave variegata Jacobi	do	Do.
Bravoa geminiflora Llav. & Lex		Do.
Polianthes tuberosa L	Amole	Do.
Prochnyanthes viridescens Watson	Amolilla, amole	Do.
Zephyranthes carinata Herbert		Bulbs.

The above list of soap plants are all used in their native state. The following is a list of plants which furnish oil used in soap making. Only five species are given although doubtless others are used.

Mexican plants furnishing oils used in soap making.

Specific name.	Common name.	Part used.
MALVACEAE.		
Gossypium spp		Seeds.
PEDALIACEAE.		
Sesamum indicum L.	Ajonjoli	Do.
EUPHORBIACEAE.		
Ricinus communis L.	Higuerilla	Do.
PALMACEAE.		
Attalea cohune Mart.?	Coquito	Do.
ROSACEAE.		
Licania arborea (?) Seem	Cana dulce	Fruit.

TANNING AND DYE PLANTS.

I was not able to obtain much information regarding the plants used for tanning or dyes, but a few notes were made which are here brought together.

LEGUMINOSAE.

Haematoxylon boreale Wats. BRAZIL.

The wood is known as "brazil," and is largely used throughout the country as a dyewood, giving a dark brown or red color. Among its applications was noted its use to color tomales, mats, and agave fiber.

Haematoxylon campechianum is supposed to be the logwood of commerce, but the above species is largely exported under that name, and has been for many years. Seemann, as long ago as 1848–1850, stated that the wood was largely exported from Mazatlan. It is not now so extensively exported from the west coast as formerly, but it is one of the chief exports from Altata, while much wood is shipped from Piaxtla, a small place down the coast, and also from Mazatlan.

The wood from Altata goes chiefly to Havre and Hamburg, ships often being loaded with this wood alone.

On account of this extensive cutting it is hard to find specimens of any size along the coast, but in some of the hot interior valleys large shrubs or even small trees are to be seen. Although so very common, this species is rarely collected botanically, there being specimens in the National Herbarium from only three localities. This is undoubtedly the *Haematoxylon campechianum* referred to by Seemann as coming from near Mazatlan.

Lysiloma candida Brandegee. PALO BLANCO.

A great quantity of tanbark is used at Guaymas. It is brought from Lower California in small boats. I saw one consignment of 170 bags landed June 9, 1897. Sometimes 1,000 bags are brought over at one time. Each bag contains about 200 pounds. It is worth $25 per ton in Lower California and about $30 at Guaymas.

There is a tannery some 3 miles southwest of Guaymas, which I visited. I found that the chief bark used was the palo blanco (*Lysiloma candida*), of which great quantities are consumed. It is said to be very strong in tannic acid. The work in the tannery is chiefly done by Yaqui Indians, but is superintended by Mexicans or Americans. Modern methods are followed in the treatment of the hides, etc., and a very good quality of leather is produced. "Torote" wood is used to some extent. This is perhaps *Bursera microphylla*. In this case it is not the bark that is used, but the wood. This is split up much like kindling wood into pieces 10 to 15 cm. (4 to 6 inches) long.

The cascalote bean (*Caesalpinia coriaria*) is used in tanning small hides. It is shipped in bags in great quantities from Manzanillo.

For this information and for samples I am indebted to Mr. P. B. Chism, who is well informed as to its use, and to Messrs. C. E. Randall and Frank Parkhurst.

The bark of huinecastle (*Enterolobium cyclocarpum*) is used at Colomas for tanning purposes. At Colotlan the bark from one of the oaks found on the mountain sides is used.

The specimens brought back are:

EB No. 109. Bark of *Lysiloma candida*, used in tanning.
EB No. 110. Wood of *Bursera microphylla*, used in tanning.

Jatropha spathulata occidentalis. TECOTE PRIETO.

This bush is very common on the west coast, and is, according to Dr. Palmer, sometimes exported, being used both as a dye and for tanning purposes.

FIBER PLANTS.

There are many fiber-producing plants in Mexico regarding which very much has already been written. What is now especially needed is some careful botanical research and collecting for the purpose of determining the species of plants which produce certain well-known fibers. There is no place where this work is so much needed as among the Mexican agaves. Particularly is the want noticeable in the literature of istle, or Tampico hemp. This fiber has usually been attributed to *Agave heteracantha*, but it is now known that several very different plants, one at least being a yucca, furnish fiber for the Tampico market; and even the so-called *Agave heteracantha* seems to be an aggregate of species. Our botanical names for the Sisal hemp plant are very much confused, as several apparently very distinct species pass under the name of *Agave rigida*. Other cases might be mentioned which are scarcely less confusing.

I have not attempted here to compile the information available regarding Mexican fibers, but to bring together chiefly my own observations upon the few fiber plants met with in my travels through Mexico, and for this reason my notes are largely fragmentary.

I have also included the information collected by Mr. E. W. Nelson and Dr. E. Palmer in 1898, both of whom had been requested to gather all data they could regarding fiber plants.

PALMACEAE.

The palms are among the most valuable plants of Mexico. Their trunk supplies lumber or material for building houses, fences, etc. The leaves are used in covering houses and huts and made into mats, baskets, brushes, hats, etc. Some species furnish fiber, which is used in many ways, as for saddle sweaters, etc. These saddle sweaters, called "suadaderos," are said to be made from the trunk of some palm which is beaten into a fibrous mass. They were seen on sale in the markets of Colotlan, Guadalajara, etc.

Several species furnish edible fruits or oil, which is used in the manufacture of soap, etc. These fruit-producing palms are referred to elsewhere in this paper.

The making of hats from palm leaves is a very important industry. A species with fan-shaped leaves furnishes the fiber. At Colotlan, where I saw hats in process of making, the material came from trees growing near Tapesco, a small town near Tequila. The leaves are cut, dried, and bleached before they are brought to the market (see EB No. 31). The various segments of the leaf are cut down to the base, and each of them slit with a pin into narrow threads, 2 mm. (one-sixteenth of an inch) wide and about 4.5 dm. (1½ feet) long. The strips are tied into large bundles, and are then ready for use (see EB No. 32). Some eight of these strips are taken and worked into a very close braid, 3 mm. (one-eighth inch) wide, the strips being repeatedly moistened to make them more pliable (see EB No. 33). Then these braids (see EB No. 33) are carefully trimmed and worked into the hat, two being sewed in at a time. They are sewed together with thread made from agave fiber. The thread is made up by the workman only as needed. He keeps a large skein of the fiber at his side (see EB No. 35), and as he needs a new thread withdraws several fibers from the skein. These he draws through his mouth to moisten, and then rubs them with the palm of his hand over the upper part of his bare leg. Then he draws them through his mouth again and then over his leg, and repeats the process until the thread is complete (see EB No. 36). A tall wooden form is used to shape the hat. A plain hat made in this manner sells for $10.

Rain coats are also made from the leaves of palm and other similar leaves. They are formed of numerous overlapping leaf segments, and are said to make very satisfactory coats.

The accompanying photograph (Pl. XXXV) shows a party of Guerrero Indians returning from the Pacific coast with bundles of bleached palm leaves.

The following specimens were secured:

EB No. 3. An odd little brush made from palm leaves. It was bought from an Indian who lived in the mountains east of Acaponeta.

EB No. 2. A fly brush made from the common Sabal of Sinaloa and Territorio de Tepic.

Sabal sp.

Along the coast a species of Sabal (*Sabal* sp. nov.) which has a slender trunk is used in making corrals, the framework of huts, etc. In some places great quantities of the leaves are used to form the sides or roofs of rude huts. In Acaponeta many houses are covered in this way. Leaves for this purpose are cut in the dry season and brought to the town on the backs of donkeys. Here they are piled up and allowed to dry and bleach. In the country the roofs are not repaired until after the first hard rains have located all the leaks, and in the meantime have spoiled much of the contents of the huts.

LILIACEAE.

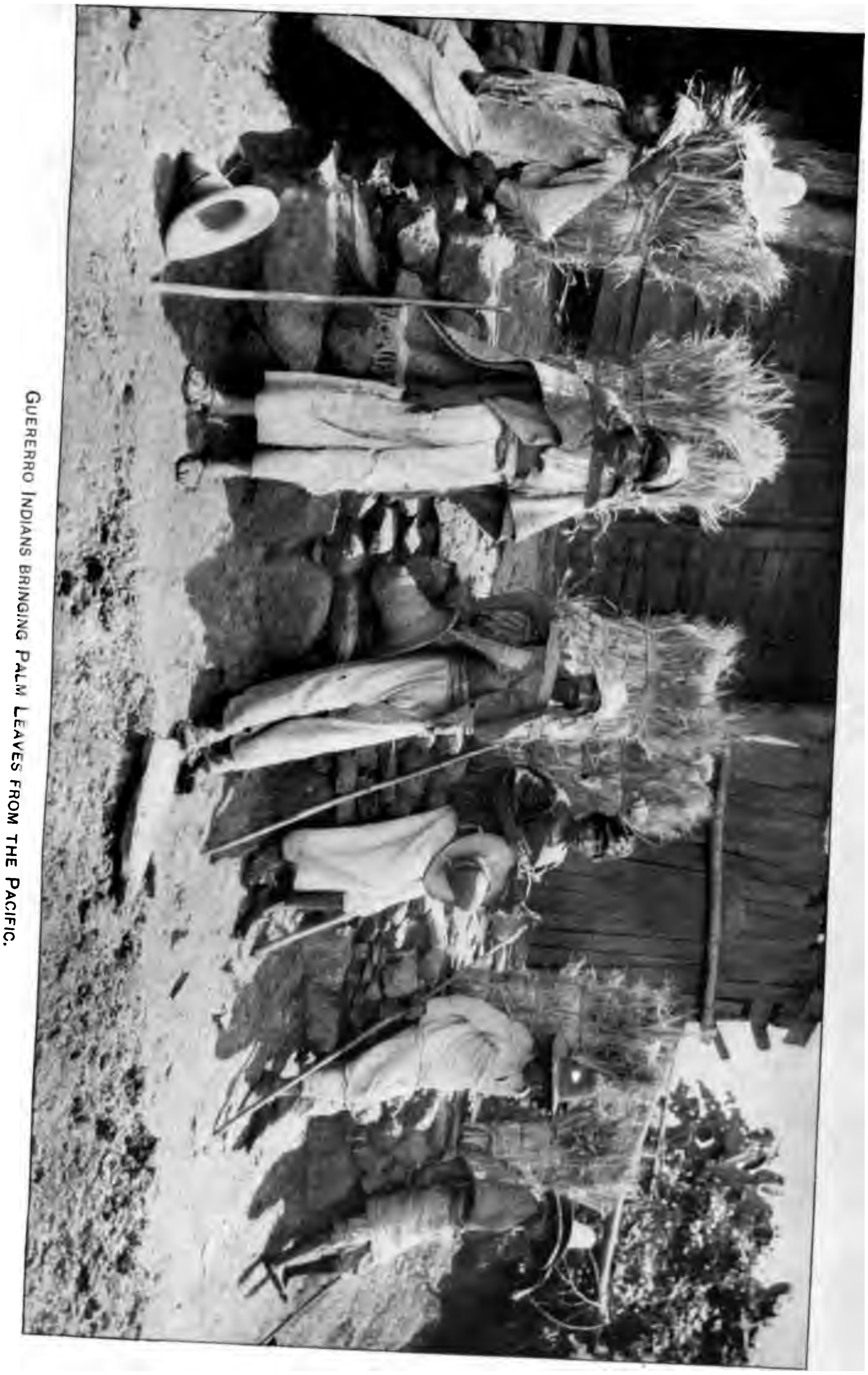
Dasylirion sp. SOTOL.

Nolina sp. SOYATE.

The leaves of both these plants are used in the making of hats, either separately or together, or mixed with wheat straw or palm leaves (Pl. XXXVI). It is very common to see bundles of leaves about the huts of the Indians or Mexicans. The leaves are laid into swaths and dried and bleached in the sun, and then stowed away for use.

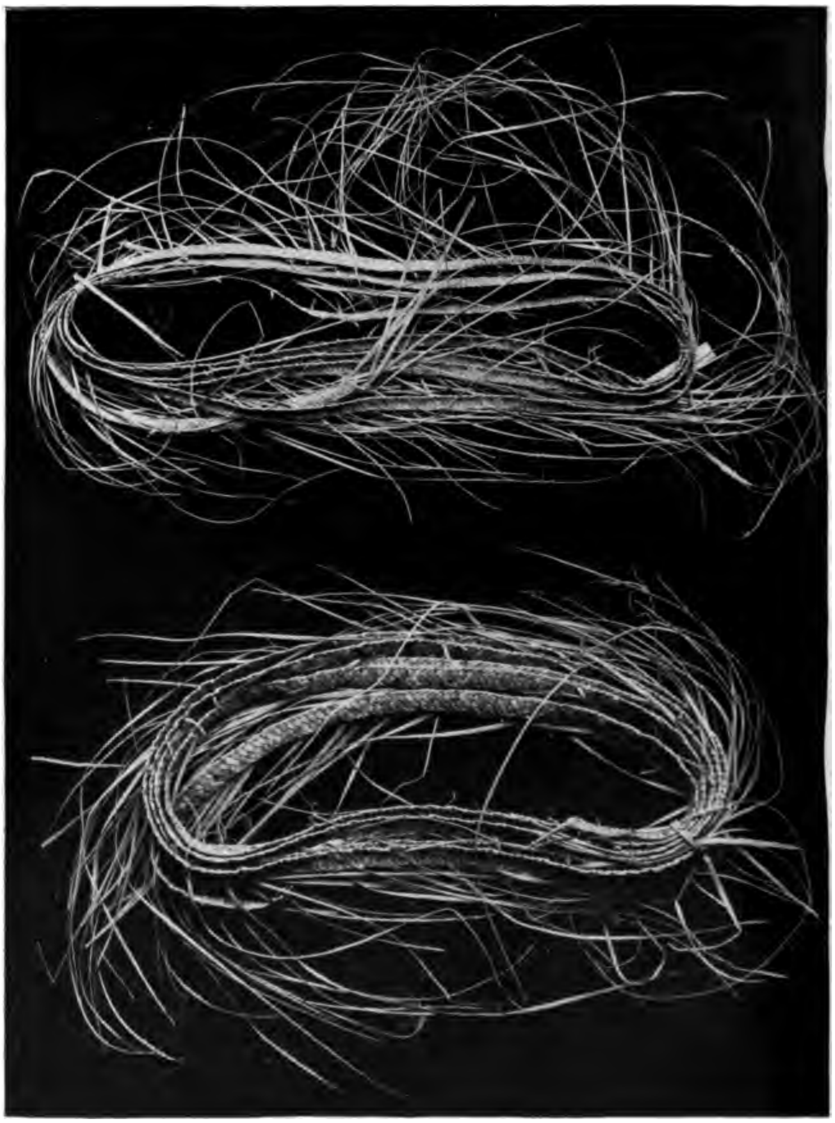
They are also made into floor mats. While many of these are roughly made, others are carefully and tastefully put together. These are sometimes banded with blue and red. The latter color is obtained by dyeing with Brazil wood and the former (so I was told) by adding

PLATE XXXV.

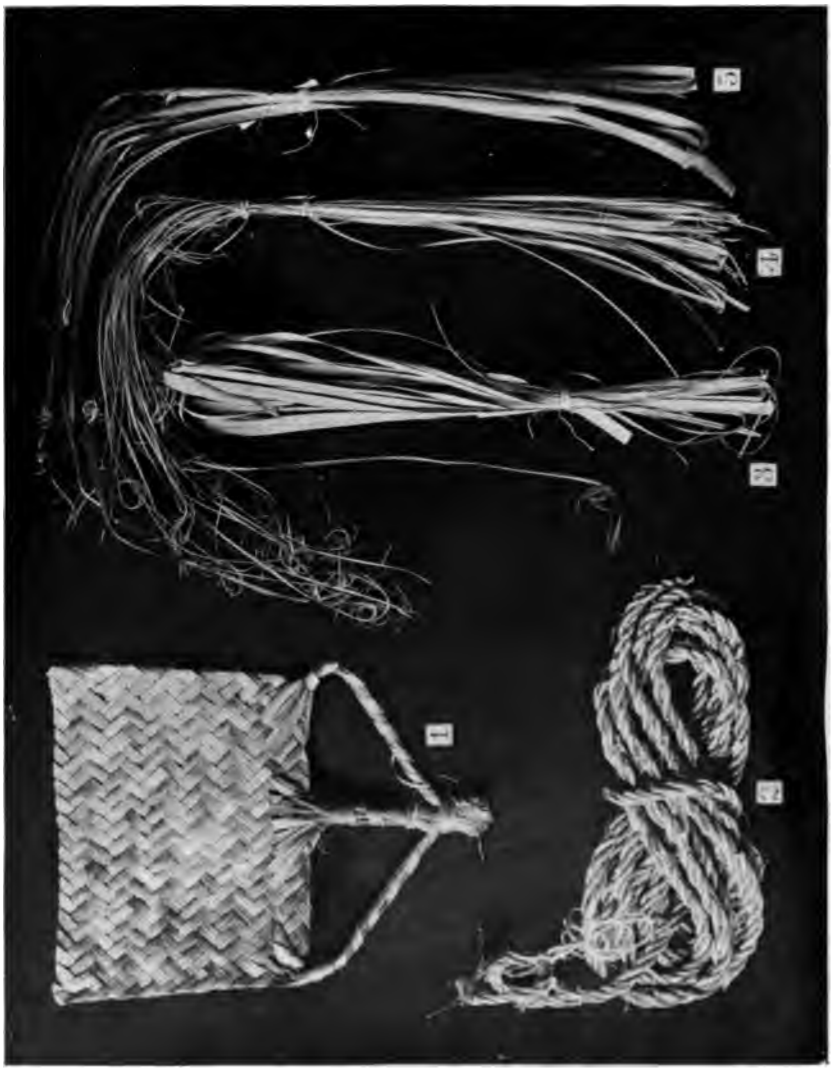


GUERRERO INDIANS BRINGING PALM LEAVES FROM THE PACIFIC.

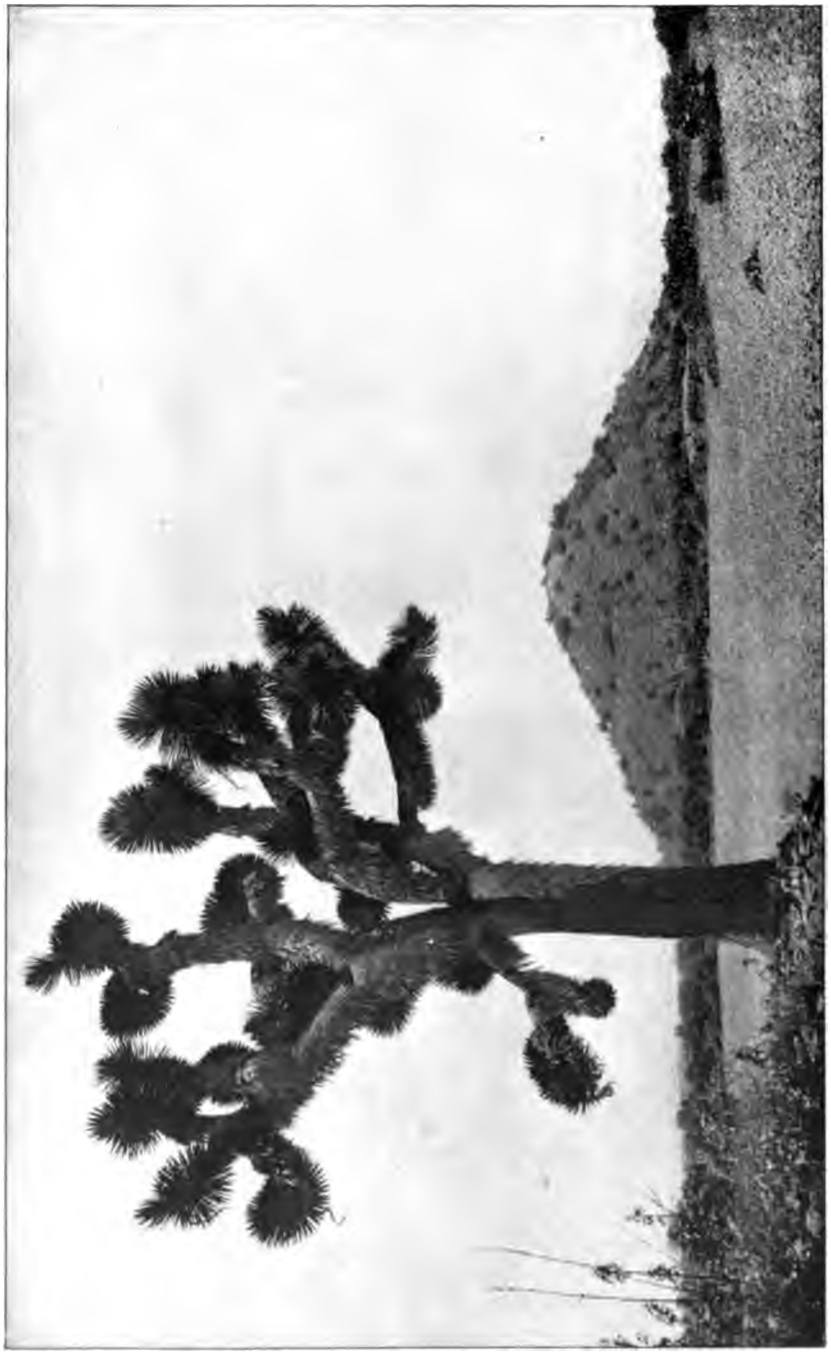
PLATE XXXVI.



HAT BRAIDS MADE FROM SOTOL AND SOYATE.



ARTICLES MADE FROM SOTOL AND SOYATE LEAVES.



ISOTE (YUCCA TRECULEANA Carr. (?)), AS SEEN NEAR THE PIRAMIDE DEL SOL, NORTHEAST OF THE CITY OF MEXICO.

lime to the Brazil wood dye. These mats are often spread on the ground or over board or bamboo-covered cots to sleep upon. By twisting the leaves rude ropes are made, a specimen of which I obtained at Plateado. A fan-shaped blower, made by braiding the leaves, is much used in starting fires (Pl. XXXVII).

The following specimens were obtained:

EB No. 114. Leaves of sotol in the process of bleaching.

EB No. 39. The same partially bleached and split into strips suitable for braiding into hats.

EB No. 40. The same mixed with soyate made into hat braid which is left untrimmed.

EB No. 41. Leaves of soyate partially bleached.

EB No. 42. Untrimmed hat braid made from leaves of soyate.

EB No. 44. A blower made from the leaves of sotol.

EB No. 52. Mat made from green leaves of sotol.

EB No. 38. A small rope made from leaves of the soyate. This was obtained at Plateado, Zacatecas.

EXPLANATION OF PLATE XXXVII.—Fig. 1, fire blower made from sotol leaves; fig. 2, rope made from sotol leaves; fig. 3, soyate leaves used in hat making; figs. 4, 5, sotol leaves used in hat making.

Yucca filifera Chabaud. PALMA LOCA.

There has been some confusion heretofore as to the botanical name of the palma loca. In the Kew Bulletin for 1890 it was stated to be *Agave striata*, but Mr. Nelson's notes and specimens seem to establish that it is a Yucca.

Mr. Nelson writes of it as follows:

> The palma loca is the single-stemmed Yucca with upright flower stalk, and is very abundant. The fiber is more abundant than in the lechuguilla but is a little more difficult to obtain and is coarser and more brittle, so that its commercial value is less. An attempt was made at Miquihuana a few years ago to export this fiber, but it was given up in favor of the lechuguilla. The trial shipment was sent to New York.

The cleaned fiber is about 5 dm. long.

Mr. Nelson's specimens may be described as follows: Stems 1.8 to 7.5 meters high; leaves 6 dm. long, 4 cm. broad at widest point, narrowed to 2 cm. at the base and upward to a stout spine 1.5 to 2 cm. long, the margin splitting off into long threads; flower stalk single and upright. Leaves and fiber were collected by Mr. E. W. Nelson, at Matehuala, Tamaulipas, 1898.

Yucca treculeana (?) Carr. ISOTE.

The isote is a tall arborescent Yucca very common in the western table-lands. This plant sometimes reaches 15 meters in height, with a trunk 24 dm. in diameter. The leaves are 6 to 7 dm. long, and are cut into narrow strips by the country people and used as strings for tying grass brooms, and for stringing crab apples (tejocotes). (Pl. XXXVIII.)

Specimens were obtained as follows:

EB No. 64. A strand of Crataegus fruits upon isote fiber.

EB No. 65, 66. A narrow strip of the fiber.

EB No. 67. A part of the leaf from which strips were being taken.

EB No. 68. An entire leaf.

AMARYLLIDACEAE.

Agave spp. MAGUEY, LECHUGUILLA, TAPEMETE, etc.

By far the most important fiber-producing plants are the numerous species of agave. These have various common and local names.

The maguey is a generic term applied to most of the agaves proper, usually with some specific designation. Lechuguilla, meaning "cabbage-like," is applied to several of the smaller agaves and manfredas, as well as to plants in other families. (Pl. XLVII.)

The quality of the agave fibers varies greatly in the different species, being suitable in some for making the finest thread, while in others it is used in making great ropes and cables. Not only are all kinds of threads, strings, and ropes made from the various qualities of agave fiber, but it is woven into many kinds of cloth, handbags, ore and grain sacks, matting, etc., or made up into brushes for scouring, for whitewashing, and for toilet purposes.

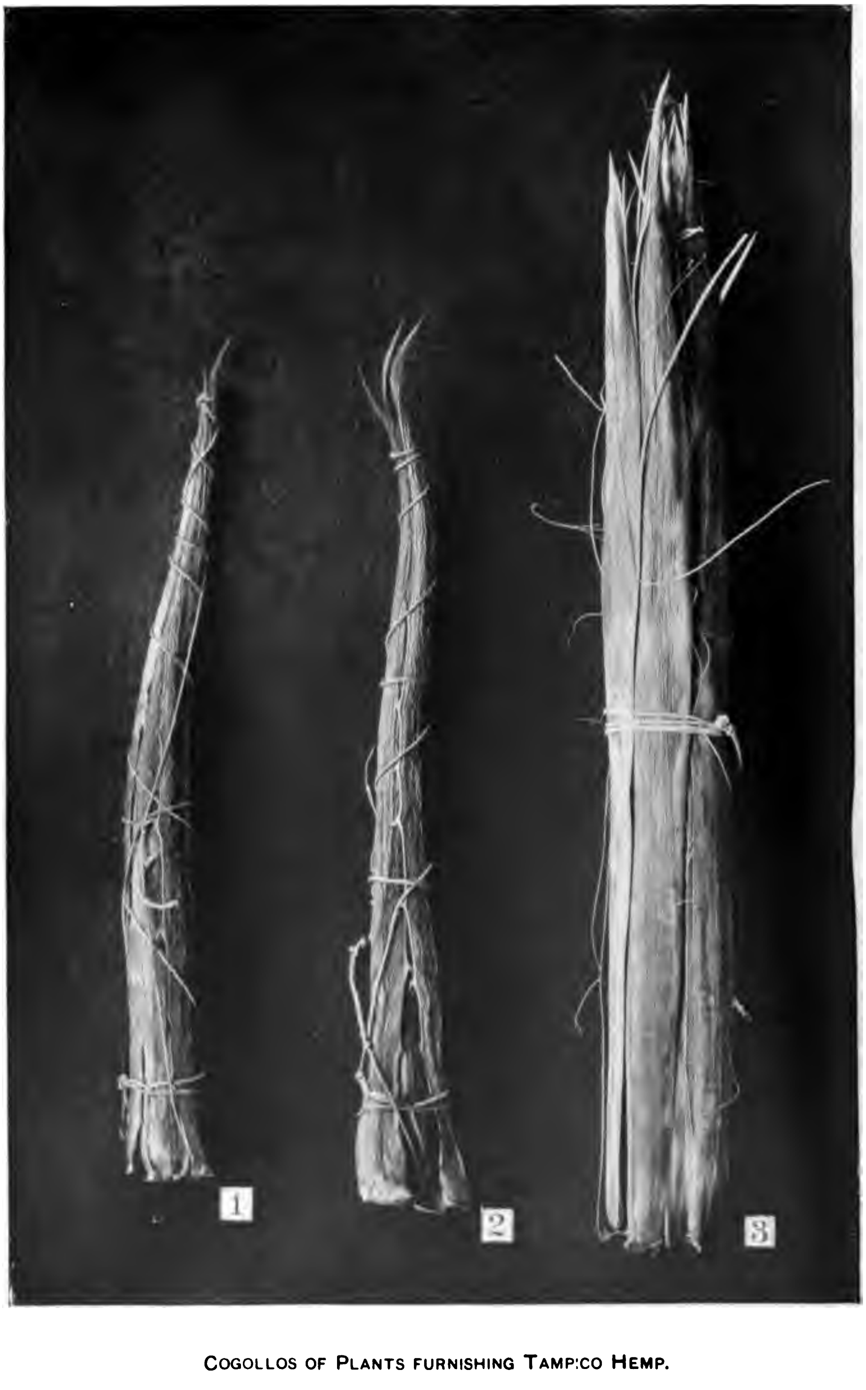
In all the interior parts of the country the people obtain their supply from their local species, each locality having one or more, or else they bring the leaves from the neighboring mountains.

Along our southern border, especially in the vicinity of El Paso, Tex., *Agave lechuguilla* is very abundant, and from it a short coarse fiber is obtained. This species has been confused with *A. heteracantha*, from which, although the two are closely related, it appears to be distinct. It is not unlikely that *A. lechuguilla* may furnish a part of the Tampico hemp of commerce. It is a rather small species, having only 20 to 30 leaves. The leaves are about 26 cm. (10 inches) long and 25 mm. (1 inch) broad, green and not at all banded down the face. Our herbarium seems to show at least four good species of the *heteracantha* group, all from the general region from which the Tampico hemp is produced. I should not hesitate to describe some of them as new if I understood what is really the type of *A. heteracantha* Zucc. and *A. poselgerii* Salm. I have the type of *A. lechuguilla* and have seen the description of *A. heteracantha*, but the latter answers to no specimens we have.

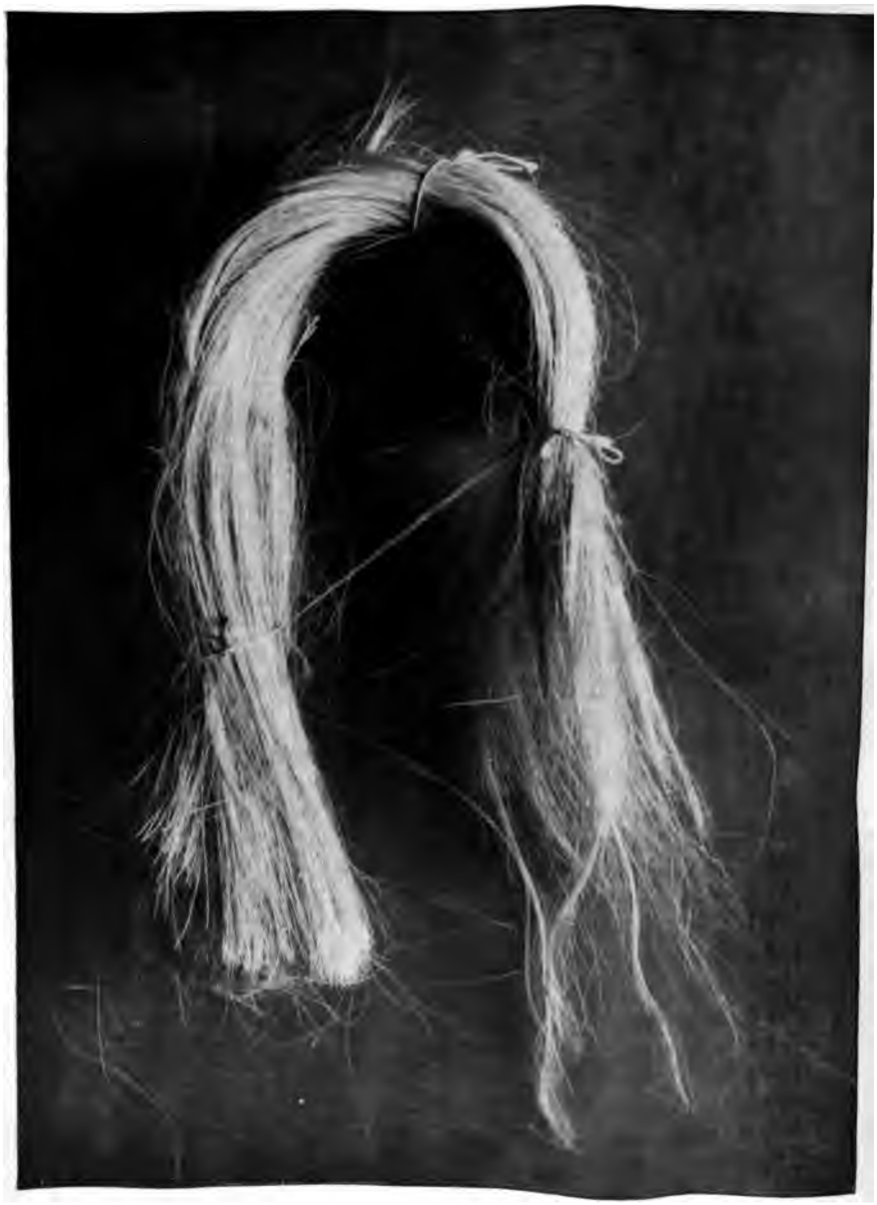
Mr. E. W. Nelson collected leaves, flowers, and fibers of two species of agave in Jaumave Valley and near Matehuala, Tamaulipas, which he states are the ixtle fiber plants of that region, and whose fiber is sent to Tampico for shipment.

One of these is perhaps *A. lophantha*, but as only two "cogollos" (bunches of young leaves) were collected the identification is uncertain. Even in these young leaves the marginal spines are widely separated, in some cases being 5 cm. apart and in this respect unlike the following species. The leaves of both differ from those of the *A. heteracantha* group in being narrowed at base.

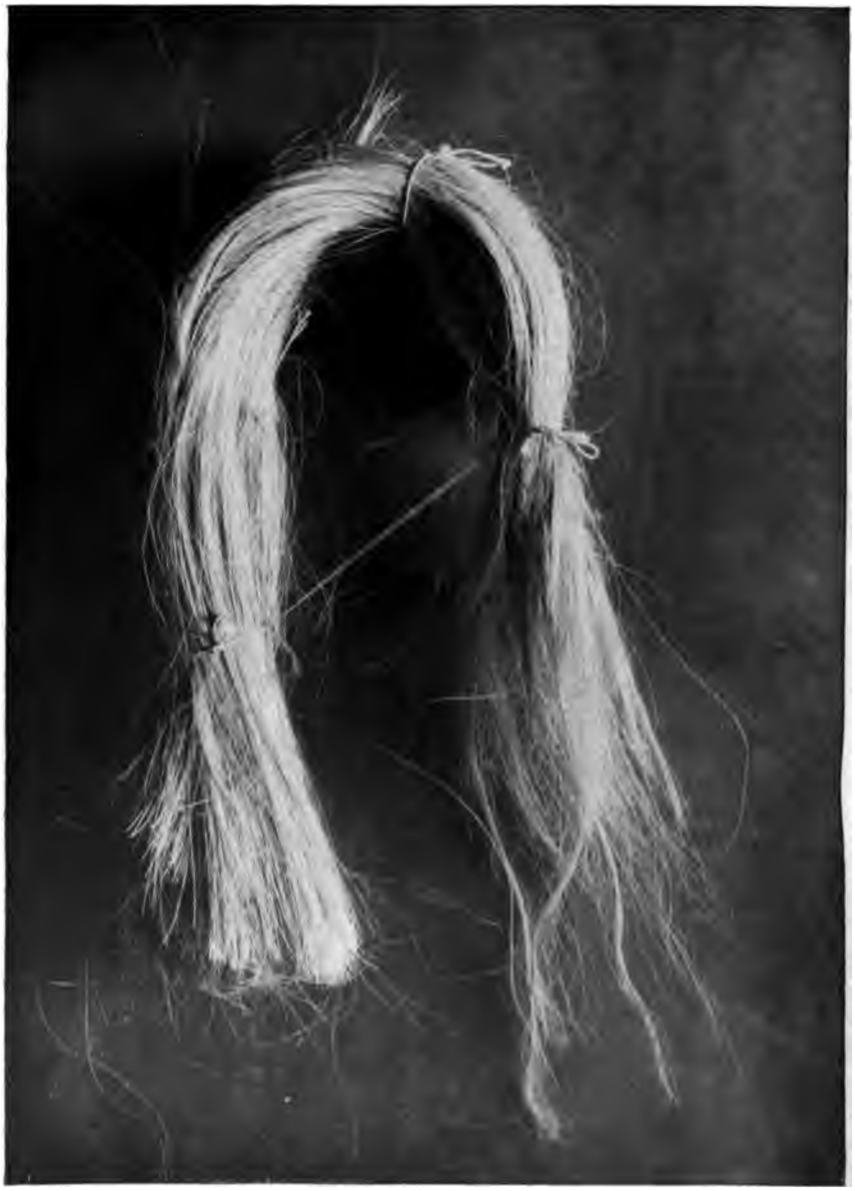
I have identified the other as *Agave univittata* Haw. The leaves almost exactly agree with specimens recently sent me from Kew,



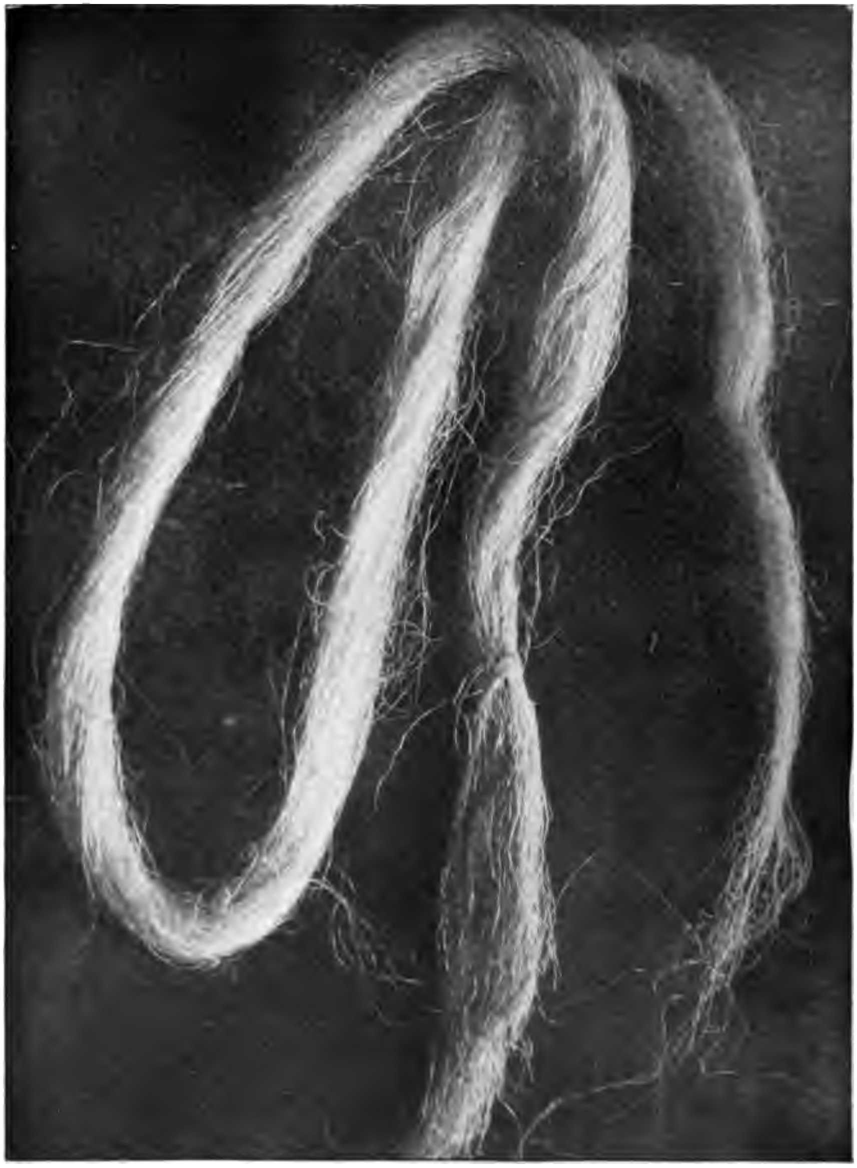
COGOLLOS OF PLANTS FURNISHING TAMPICO HEMP.



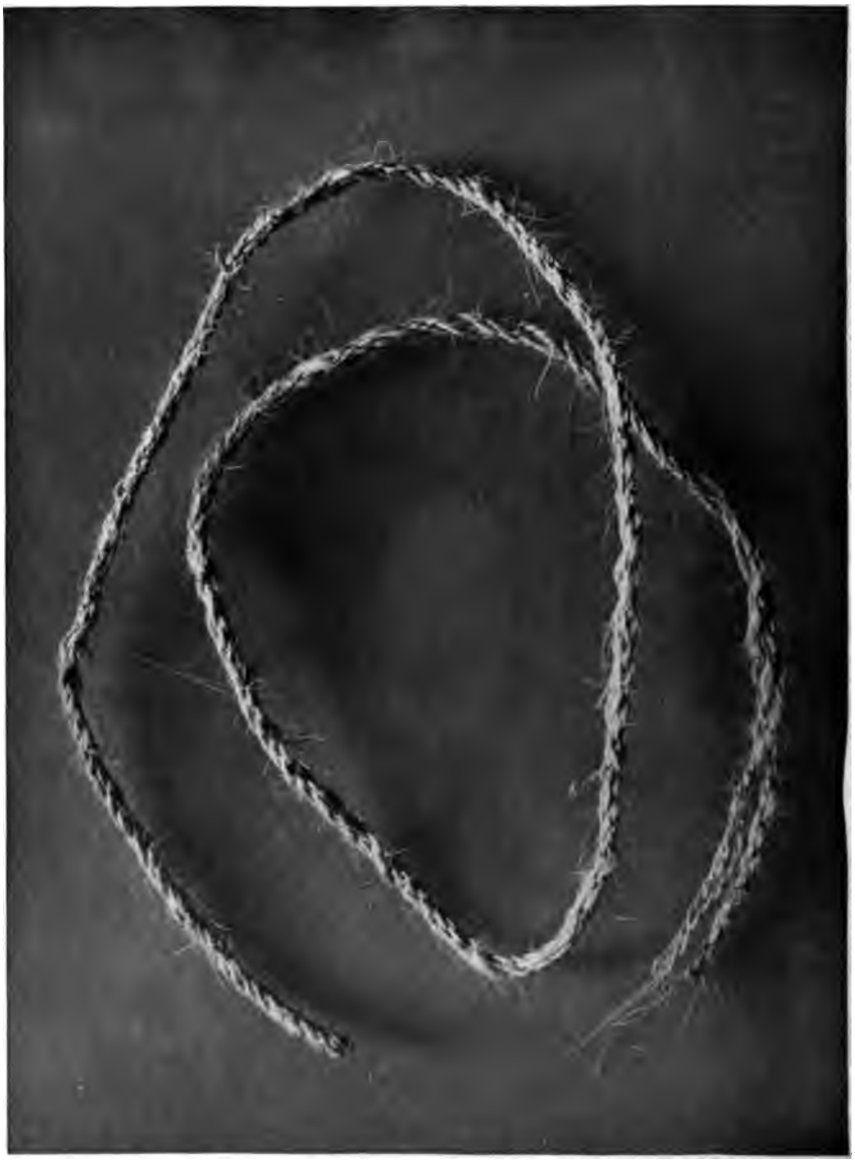
SMALL BUNCH OF TAMPICO FIBER.



SMALL BUNCH OF TAMPICO FIBER.

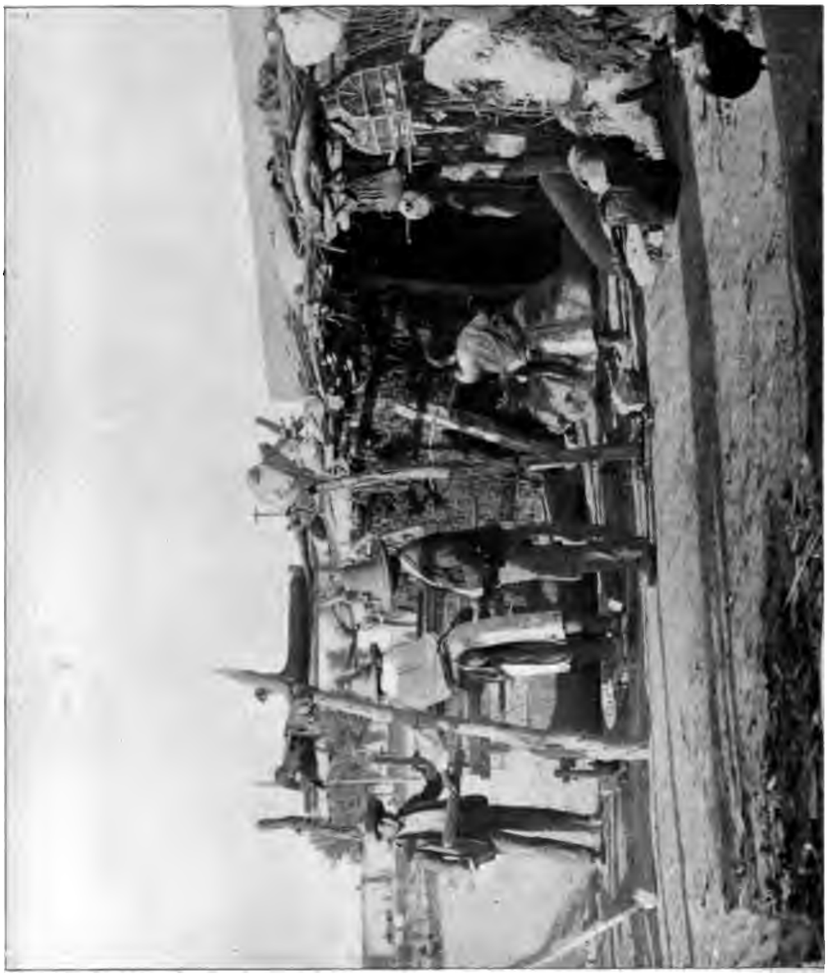


SMALL BUNCH OF TAMPICO FIBER.



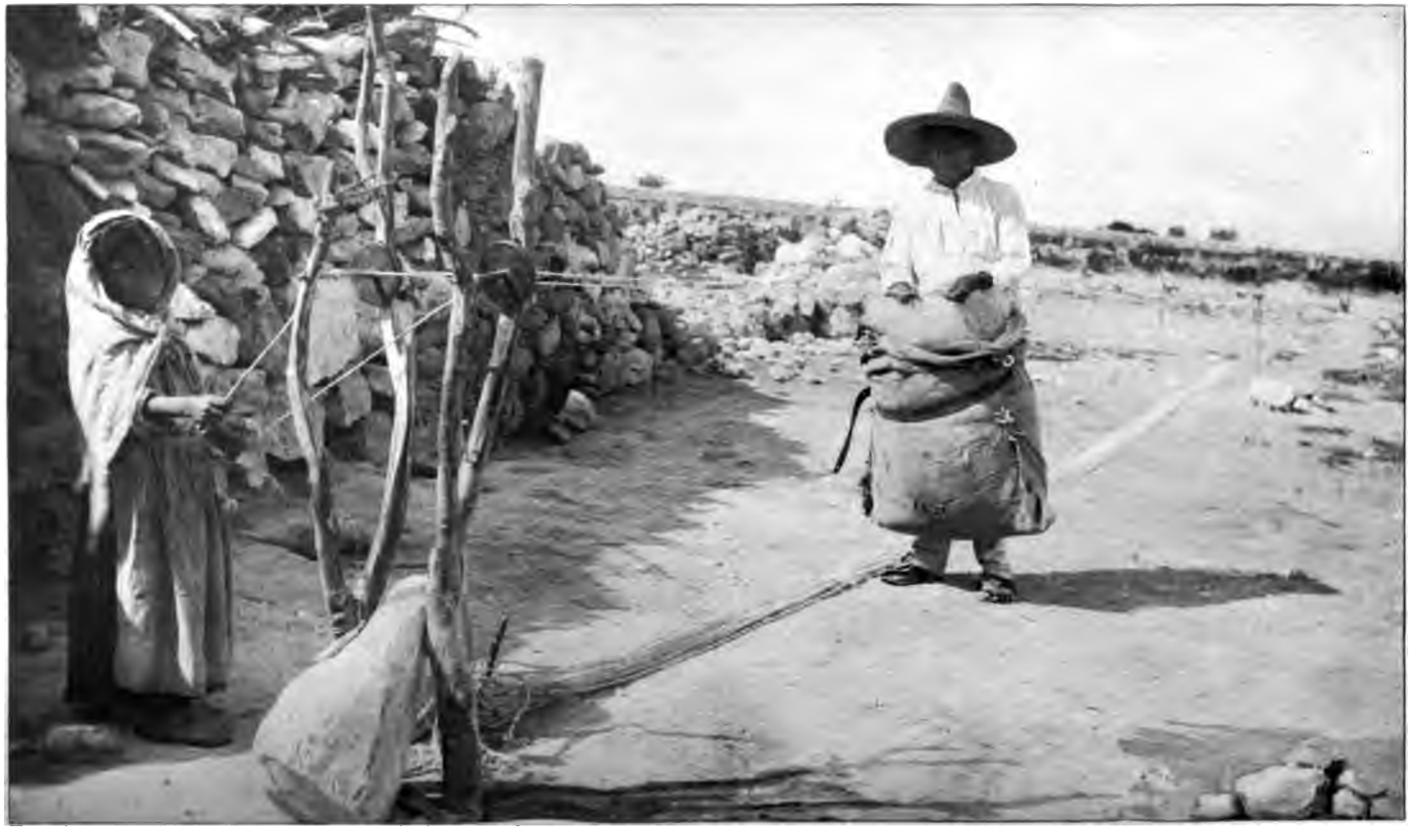
STRING MADE BY HAND FROM TAMPICO FIBER.

PLATE XLIV.



MEXICANS MAKING BAGGING OUT OF IXTLE FIBER.

PLATE XLV.



PROCESS OF TWISTING IXTLE FIBER INTO TWINE.

England, although they do not agree with the illustration of this species as given in Saunders's Refugium Botanicum.

Mr. Nelson's specimens may be described as follows: Leaves 25 to 50, 5 dm. long by 3 cm. wide near the middle, scarcely narrowed toward the base, green or somewhat glaucous-green with a pale band down the middle of the face, which, however, fades out in the dried specimens; flowering stalk glaucous; the bracts among the flowers filiform, 5 cm. long, persistent; the ovary 14 to 15 mm. long, glaucous, constricted above; the perianth tube very short, 2 to 3 mm. long, with lobes 15 mm. long, described as yellow, but when dry of a reddish tinge; the stamens twice as long as the segments. This agave is also known as lechuguilla.

Mr. Nelson writes of these species as follows:

> These plants grow wild in the greatest abundance on limestone mountains and adjacent valleys from near Victoria, Tamaulipas, to the Mexican National Railroad, in San Luis Potosi, and from Peotillas, in San Luis Potosi, north to near Saltillo, Coahuila. From within this area many million pounds are exported (via Tampico) each year, nearly the entire product going to the United States.
>
> The ixtle fiber shipped from Tampico is produced mainly in the region about the valley of Jaumave and valley of Tula, in western Tamaulipas and adjacent part of eastern San Luis Potosi. The production of this fiber is the main industry of a considerable area, with the towns of Jaumave and Tula as the centers. The fiber from the Jaumave district is shipped by pack animals to the town of Victoria, on the Monterey and Gulf Railroad, and thence by rail to Tampico. The Tula Valley output is sent to Cenito, on the Mexican Central Railroad, in eastern San Luis Potosi, and sent by rail thence to Tampico. Wagon roads lead out from Tula to the railroad, and the State government has had a large force of convicts working for a number of years building a finely constructed road from Victoria across the mountains to Jaumave. The fiber of this region is produced in the arid lower austral zone at altitudes between 2,000 and 5,000 feet. The leaves are from 15 to 30 inches long. Only the tender, unfolded leaves forming the central bunch are used, as the fiber of the old outer leaves is too coarse and brittle. This central spike of unopened leaves called "cogollo" (Pl. XXXIX) is gathered by means of a short staff, 4 feet long, with an iron ring fitted by a ferrule to one end. The iron ring is slipped over the cogollo and a quick wrench breaks it loose, and it is then placed in a basket on the laborer's back. The man gathers a back load in this way and proceeds to a large bush or small tree, where he can get shelter from the sun, and, placing the leaves in a heap near the base of the tree, proceeds to clean out the fiber.

EXPLANATION OF PLATE XXXIX.—Figs. 1, 2, cogollos of an agave which furnishes Tampico hemp; fig. 3, cogollo of a Yucca which furnishes Tampico hemp.

"Tampico fiber" is a term applied to all fiber shipped from the port of Tampico on the Gulf coast of Northern Mexico (Pls. XL to XLIII). It is usually considered to be synonomous with ixtle[1] (Pls. XLIV to XLVI). A better classification, however, is to confine "ixtle" to the fiber of the short-leaved agave, and apply "palma loca" to the fiber of the Yucca, and "guapilla" to the fiber of the linear-leaved agave.

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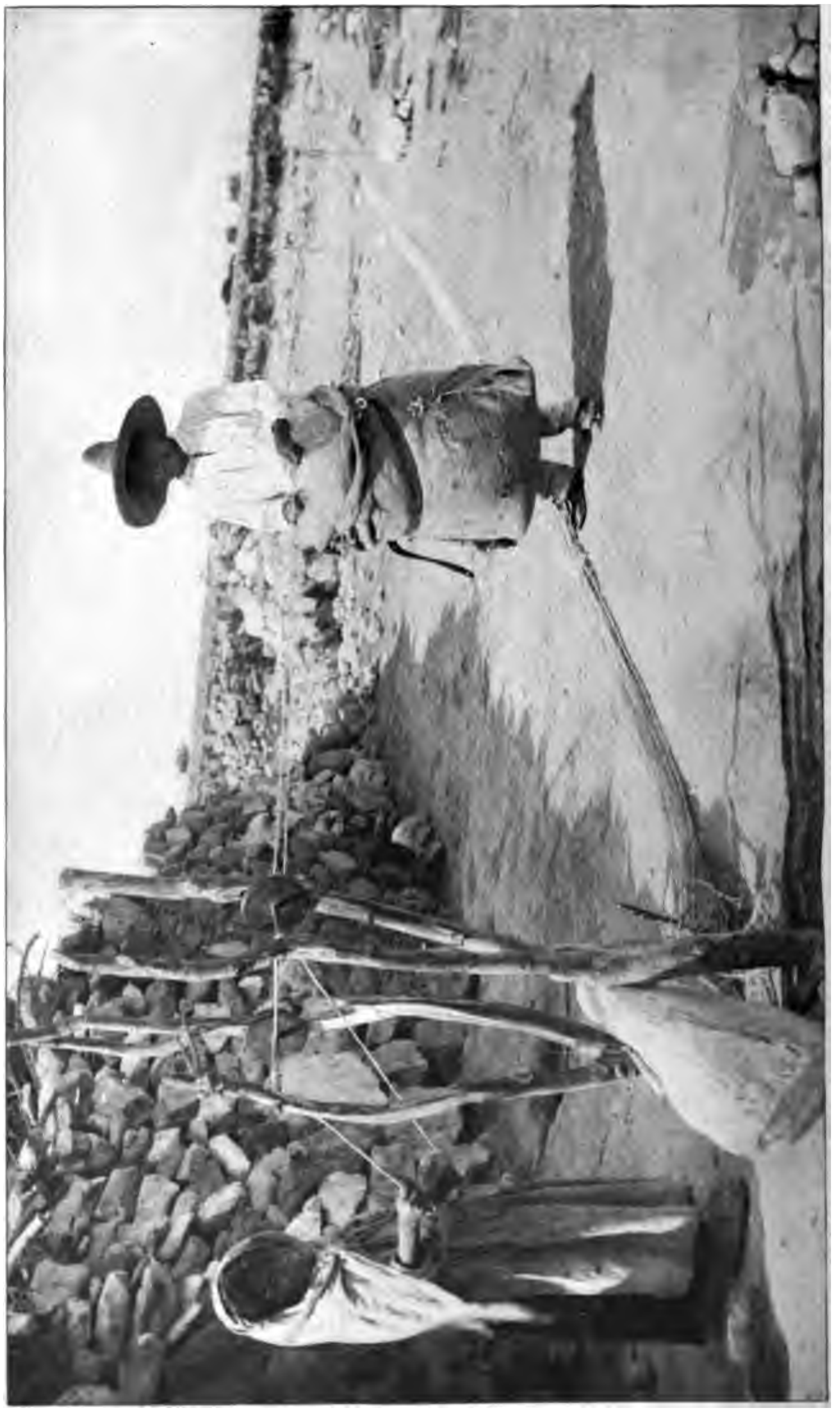
[1] By various authorities ixtle is stated to be the fiber of *Bromelia sylvestris*. The name is also sometimes applied to sisal hemp. *Agave ixtle* does not seem to furnish ixtle fiber.



PROCESS OF TWISTING IXTLE FIBER INTO TWINE.

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Ixtle fiber is shipped to Tampico especially from San Luis Potosi, Tereone, Saltillo, Tula, and Victoria, where it forms one of the principal articles of export.

According to United States Government reports for the year of 1897–98, our supply of ixtle was from the following places, arranged according to quantity: Tampico, Saltillo, Monterey, San Luis Potosi, Victoria, Porfirio Diaz, and Matamoras. The amount, valued in American money, declared for shipment to the United States, was as follows: Tampico, $62,002.42; Saltillo, $45,476.43; Monterey, $35,659.49; San Luis Potosi, $14,424.86; Victoria, $4,220.67; Porfirio Diaz, $1,912.56; Matamoras, $582.50. From these reports it might be inferred that Tampico is the immediate center of a fiber-producing district, but this is not the case. No fiber is produced near Tampico, but it comes from the mountains and table-land region, some 300 miles to the west. The other towns mentioned are the chief centers of the Tampico hemp industry.

Imports for consumption of Tampico hemp into the United States from 1884 to 1898.[1]

Year.	Tons.	Value.	Value per ton.	Year.	Tons.	Value.	Value per ton.
1884	339.12	$37,832	$111.56	1892	4,646.50	$325,058	$69.96
1885	3,247.64	294,636	90.71	1893	4,579.88	264,617	57.78
1886	3,895.19	326.311	83.77	1894	5,127.00	286,231	55.82
1887	2,181.30	165,156	75.71	1895	9,708.00	458,404	47.22
1888	1,933.26	153,011	79.15	1896	12,205.00	717,585	58.79
1889	3,480.03	292,934	83.96	1897	6,299.08	335,241	53.22
1890	5,304.60	463,112	87.30	1898	2.556.00	129,921	50.83
1891	5,455.33	409,720	86.11				

The following are the most important Mexican terms relating to this plant:[2]

Lechuguilla—the plant itself (Pl. XLVII, figs. 1, 2, and 4). Also applied to various plants other than agave.

Cogollo (sometimes wrongly spelled cogolho), the cone of young leaves from which the fiber is taken (Pls. XXXIX, XLVII, fig. 1). Also applied to the young crown leaves of yucca, etc.

Ixtle—sometimes spelled istle and ystle—the fiber.

Burro, the instrument used to wrench loose the cogollo.

Tallador, or fierro tallador, the scraper.

Estoca banco, the block on which the fiber is cleaned.

Retranca, the small peg which braces the estoca.

Banco del ide, the large peg with notch under which the end of the tallador is placed.

Boliyo, the grasper.

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[1] Commerce and Navigation of the United States, 1896, vol. 2, p. 1159. Same, 1897, vol. 1, p. 535; 1898, vol. 1, p. 617.

[2] For illustrations of instruments see Pls. XLVII to XLIX.

Agave americana L.

This seems not to be very common in western Mexico. I saw only a few cultivated specimens, and those always about settlements. The Indians of the Sierra Madre claim to obtain from it a fine soft fiber used chiefly for thread. Contrary to general belief, *Agave americana* has little economic value as compared with some of the other species.

Herbarium specimens only were obtained of this species.

Agave cochlearis (?) Jacobi. PULQUE MAGUEY.

Mr. Nelson says of this fiber that it is very fine and strong and used for making fine cord, soft rope, small bags for carrying food or other small articles, and sweater pads for pack saddles. Owing to the fleshy character of the leaves the extraction of the fiber is difficult and expensive, so that the fiber is not of commercial importance. With suitable machinery, however, it ought to be worked profitably. Its fiber is 12 dm. (4 feet) or more long, nearly white, and very soft.

Unfortunately Mr. Nelson collected no botanical specimens, and the identification of the species is largely guesswork. It is customary to refer all the large fleshy-leaved pulque magueys to *Agave atrovirens*, while in fact several very distinct forms are readily recognized in the field. The commonest of these agaves in western Mexico—and I have also seen specimens of the same from San Luis Potosi and Saltillo—does not answer to the description of *A. atrovirens*. I have tentatively called it *A. cochlearis*, as it answers to this species better than any other which Mr. J. G. Baker recognizes in his monograph of this genus.

Agave falcata Engelm. GUAPILLA.

Mr. Nelson states that the leaves are put into boiling water to wilt them, which facilitates the cleaning out of the fiber. He also says that the fiber is fine and soft, but difficult to obtain and not of commercial importance. This is perhaps the same fiber referred to in the Kew Bulletin as coming from Tula, although the plant is called *Agave striata*, and the Mexican name is given as "palma loca."

A. falcata may be the same as *A. striata*, although Mr. Baker keeps them distinct. I have carefully compared these leaves with garden specimens and really find no grounds for separation. Still, living specimens of both should be studied before the question of specific identity is determined. In any case this agave from north Mexico is the *A. falcata* described by Engelmann. It is very common in north Mexico. Herbarium specimens were collected by Mr. E. W. Nelson in Jaumave Valley, June 1, 1898 (No. 4457), and in the Sierra Encarnacione, Coahuila, July 28, 1896 (No. 3891). Fiber and leaves were also sent from Matehuala. The latter are more than 9 dm. (1 yard) long.

Agave geminiflora Ker-Gawl.

The Cora Indians in the mountains of the Territorio de Tepic obtain a very soft fiber from one of their local plants, which is probably *Agave geminiflora*.

Herbarium specimens and samples said to be its fiber were brought back.

Agave vivipara L. **Tapemete.**

The most common agave seen in western Mexico was *A. vivipara*. This species is restricted to the tropics, being found from near sea level up to about 3,000 feet altitude. It was seen as far north as Guaymas, and extends at least as far south as Acapulco. It does not grow in the United States, as is sometimes stated. It was seen on the sides of all the tropical valleys which I crossed in Territorio de Tepic, Zacatecas, and Jalisco, and may be found as far south as the City of Mexico. This species yields considerable fiber, at least for local consumption. The fibers are about 2 feet long, of medium weight and good strength. I saw it used only in making a coarse thread or twine for knitting the rude hand bags so generally carried by the country people. Strings are also made by cutting off narrow strips from the leaves, as one would from rawhide. The plant is known as "tapemete." In this species the leaves are 7 to 9 dm. (28 to 36 inches) long, about 3.5 cm. (1½ inches) broad, and more or less glaucous, and the margins have small brown prickles. (For fiber, see Pl. LII.)

Its alliances seem to be with the Rigidae group. It does not closely resemble *Agave virginica* (*Manfreda*), as is stated in some reference books.

Numerous herbarium specimens, and specimens of fiber and fiber products of this species, were brought back.

Agave sp. **Huila.**

In the little town of Bolaños, State of Jalisco, the natives extract considerable fiber from one of their cultivated agaves, which they call "huila." It yields a very coarse, harsh fiber, used mostly for making heavy ropes. This species has not been determined definitely. It appears to be the one so much employed in the manufacture of mescal.

Good herbarium specimens and specimens of fiber were obtained.

Agave sp.

In southeastern Sinaloa an agave grows on the sides of the highest mountains (altitude about 3,000 feet) which is said to be used by the people of that region for its fiber. I did not see any of it, however, in use, and so was not able to confirm the statement. But it is certainly true that the plant has a good, strong fiber. This species appears to be new to science. It produces about 20 leaves, which are 6 to 8 dm. (24 to 32 inches) long and 7.5 to 8.5 cm. (3 to 3⅜ inches) broad at the widest part, with the margin closely serrate and the apex tapering into a long, weak spine.

Good herbarium and living specimens of this species were brought back to Washington.

Agave spp.

In the Sierra Madre the people obtain most of their fiber from two or three closely related species. These species are of the *A. filifera* type, having linear leaves and a pungent tip, while the margin frays off into white threads. One of these species is the recently described

A. vestita, while two of the others appear to be undescribed. They all yield a strong fiber which is made into ropes.

Herbarium specimens, leaves, fiber, and living specimens were obtained of these species.

The following agaves collected by the writer are reported to furnish fiber. As some of them have not been determined specifically, the collection number and also the locality are given, with the hope that it may lead some one to procure more material.

Name.	Number.	Locality.
Agave sp. nov	1713	Southeast Sinaloa.
Agave lechuguilla Torr	1199	Chihuahua, near El Paso.
Agave rigida elongata Baker	1307	La Paz, Lower California.
Agave sp	2755	Bolaños, etc.
Agave americana L	2146	Mountains of Tepic, etc.
Agave geminiflora Ker-Gawl	1625	In Sinaloa, Tepic, etc.
Agave vestita Watson	3767	Zacatecas, etc.
Agave vivipara (?) L	3537	In Sinaloa, etc.
Agave sp. (?)	2200	Sierra Madre.
Agave sp	2400	Do.

The following species are those recently sent in by Dr. Palmer and Mr. Nelson:

Name.	Collector.	Locality.
Agave falcata Engelm	Mr. Nelson	Tamaulipas, etc.
Agave univittata Haw	do	Do.
Agave lophantha Schiede	do	Do.
Agave cochlearis Jacobi	do	Do.
Agave heteracantha (?) Zucc	Dr. Palmer	Saltillo.
Agave heteracantha (?) Zucc	do	San Luis Potosi.

When the Descriptive Catalogue of Useful Fiber Plants of the World was published by the Department of Agriculture in 1897, only ten species were sufficiently well known to be described. These are given below. Only three of them are identical with plants in my list. Undoubtedly a score or more species are used locally in Mexico for their fiber.

Agave americana.
Agave aurea.
Agave decipiens.
Agave heteracantha.
Agave mexicana.
Agave morrisii.
Agave potatorum.
Agave rigida elongata.
Agave rigida sisalana.
Agave vivipara.

Although I saw no fibers in process of being extracted from the leaves, I saw plenty of the raw fiber and plants from which leaves had been cut for their fiber. Some of the methods used were extremely crude. For instance, in southeastern Sinaloa I was told that the leaves were first cooked and then allowed to stand in water for several days, after which the pulpy part of the leaves is removed by rubbing them with a stick. On the table-land the end is accomplished by driving iron spikes 8 or 9 inches long into a block of wood and drawing the leaves over this instrument until all the connecting tissue is removed.

At Bolaños still a different method is employed. The leaves are first trimmed of their marginal spines and then placed flat on a board, which is about 8 inches wide and set at an angle of about 45 degrees, one end resting on the ground and the other about reaching to a man's waist. The leaf is then scraped with a rude knife, first from one end and then from the other. After a while the leaf is turned over and the same process repeated until all the connecting tissue is removed.

Mr. Nelson describes the manner of taking the ixtle fiber at Matehuala as follows:

> A short block of yucca wood is laid on the ground close to a tree and the pointed end of a long triangular blade of iron, with a wooden handle, is thrust into the base of the tree trunk and held across the block of yucca wood. The workman then strips the edges from the agave leaves to rid them of the bordering spines and, holding the butt in the right hand, lays the leaf on the wooden block and, pressing down the iron, draws the leaf through, thus scraping out most of the pulpy matter. Then a small wooden grasper with a knob at one end has the free ends of the fiber wrapped about it in a "half hitch," and by grasping this the workman can draw the leaf under the iron in a reverse direction, thus cleaning the leaf in two motions. The fiber is laid at full length on the ground and the process repeated until the supply of leaves is exhausted. Men clean from 10 to 15 pounds of fiber a day, for which they receive 2 cents a pound at Miquihuana and 2½ cents at Jaumave.

The scraper, called "tallador," referred to above has a wooden handle 12.5 cm. (5 inches) long and a triangular blade 22.5 cm. (9 inches) long, with a hooked point which can be thrust into the trunk of a tree. The block, generally of yucca wood, used as a base on which the leaves are cleaned with the tallador, is about 5 dm. (20 inches) by 6 cm. (2½ inches) by 5 cm. (2 inches). This block of wood is made firm by means of small pegs driven into the ground on each side. When the cleaning is done in the open a peculiar peg, with a special notch for the point of the tallador, is driven into the ground near the block of wood. The grasper used for seizing the end of the half-cleaned fiber is of wood, about 10 cm. (4 inches) long and somewhat larger at one end. At the smaller end there is a knob, which prevents the fiber from slipping off the grasper.

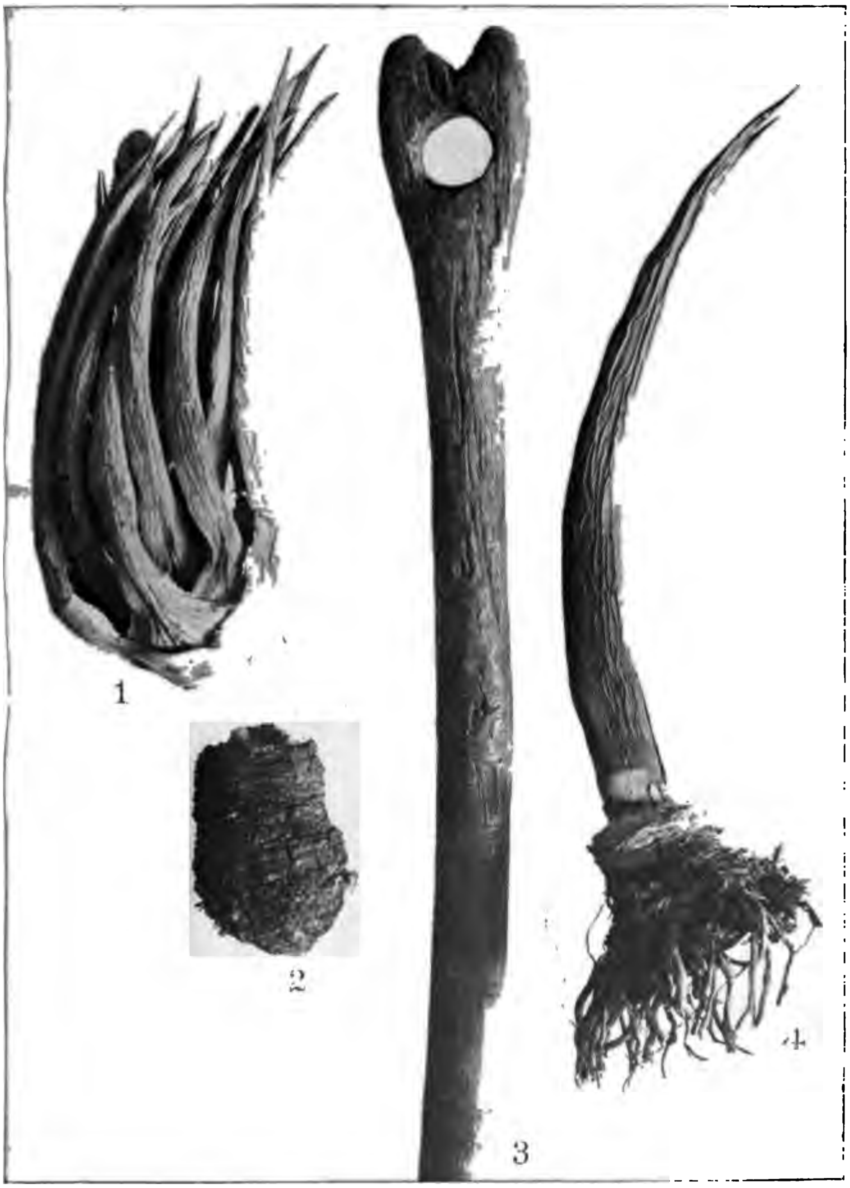
EXPLANATION OF PLATES.

PLATE XLVII.—Cogollo (central leaves) of a lechuguilla plant; fig. 2, rootstock, used for soap; fig. 3, burro, used to break off the cogollo; fig. 4, old lechuguilla plant.

PLATE XLVIII.—Fig. 1, estoca banco, consisting of a block of yucca wood; fig. 2, tallador; fig. 3, boliyo.

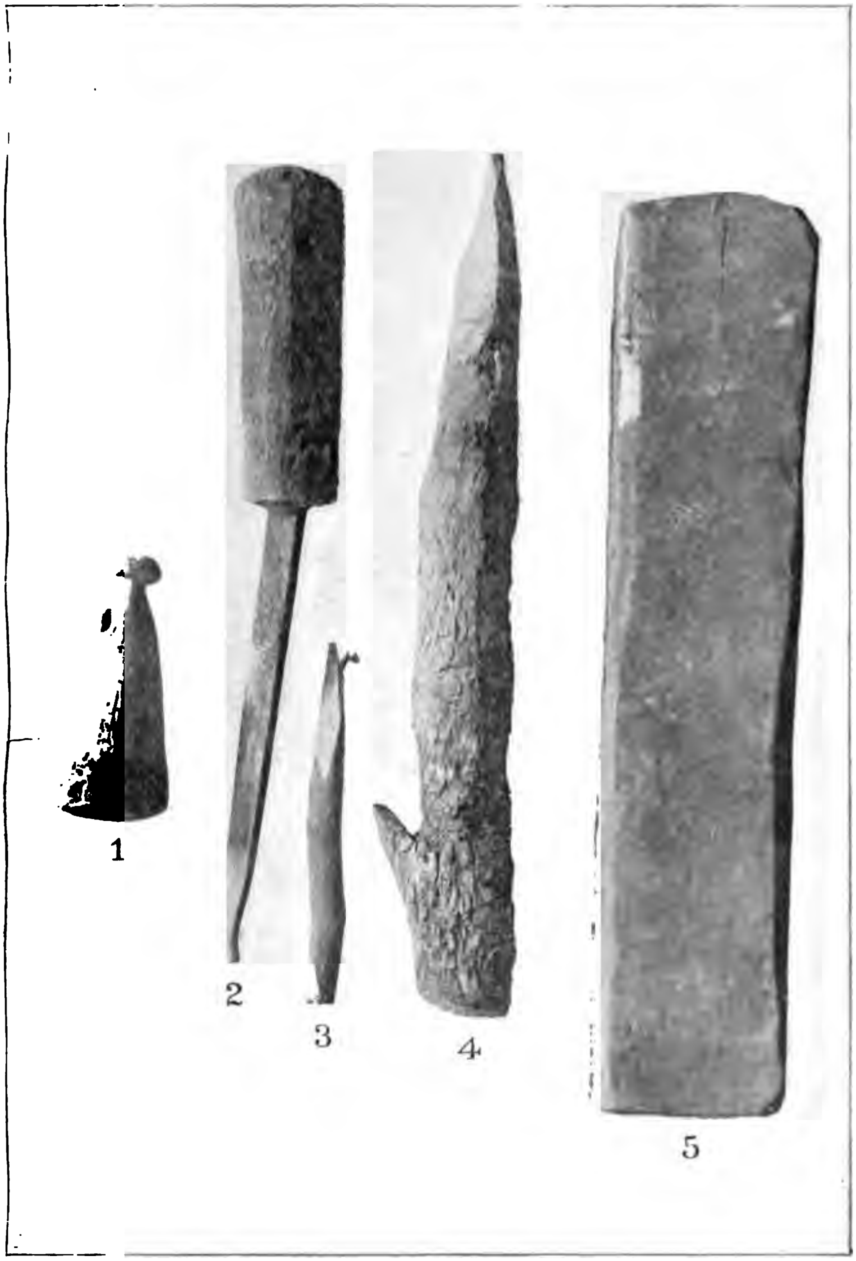
PLATE XLIX.—Fig. 1, boliyo; fig. 2, tallador; fig. 3, retranca; fig. 4, banco del ixtle; fig. 5, estoca banco.

The following list represents the specimens of fibers and fiber products which I brought back from Mexico. They are deposited in the Ethnobotanic collection of the National Museum and in the National Herbarium.



LECHUGUILLA PLANT WITH BURRO.

INSTRUMENTS USED IN EXTRACTING IXTLE FIBER.



Instruments used in extracting Ixtle Fiber.

EB No. 6. The leaves of what appears to be an undescribed species of agave of the *A. filifera* type, used by the Cora Indians at Santa Teresa, Tepic.

EB No. 7. The clean fiber ready for spinning into ropes.

EB No. 8. A rope made out of this fiber.

EB No. 10. A narrow strip from the leaf of *Agave vivipara* used in the place of strings in tying up packages of sugar.

EB No. 11. Leaves of *Agave geminiflora*, from which the Cora Indians obtain a fine fiber which is spun into hand bags.

EB No. 12. Said to be the fiber obtained from leaves of this species.

EB No. 13. A hand bag made from this fiber.

Herb. No. 2755. The leaf of *Agave vivipara*.

EB No. 14. The cleaned fiber from this species.

EB No. 15. The mixed fiber of the same ready for spinning into thread.

EB No. 16. A coarse thread or twine made from this mixed fiber.

EB No. 19. A partly finished hand bag knit out of this thread.

EB No. 45. A marginal strip from the "huila" agave, sometimes called "bastard tequila," from which a coarse fiber is taken

EB No. 46. The partially cleaned fiber.

EB No. 47. The same, but cleaner.

EB No. 48. The same mixed, ready to spin into ropes.

EB No. 35. A fine, soft agave fiber used at Colotlan for thread in hat making. The fiber is very clean and white. I did not learn definitely the species from which it was obtained, but was told that it was from one of the large species in cultivation in the town, therefore probably from either *Agave americana* or *A. cochlearis*.

EB No. 36. A rude thread used for sewing hat braids together and made from the last-mentioned fiber. The thread is made out of a few fibers which are twisted by hand.

EB No. 60. A dishcloth composed simply of a bunch of agave fibers (Pl. L, fig. 2). Obtained at Bolaños. It seems to be common to use the plain fiber in this manner for cleaning and washing. I found in my room at one of the larger hotels of Guadalajara a bunch of this fiber in place of a wash rag.

EB No. 130. A bunch of small twine bought at Guadalajara. In this city there is a whole block of stores which are given up almost entirely to the sale of these fiber products. In the smaller towns there is usually one or two stores where such things are for sale, or certain parts of the open market which is usually about the plaza are given up to them.

EB Nos. 51, 79. Rude scouring brushes which are seen in all parts of western Mexico. They are made from the bases of the leaves of *Agave vivipara*. They are 15 to 18 cm. (6 to 7 inches) long. The broad, clasping base, which is 5 to 6 cm. (3 to 4 inches) wide, forms the brush proper, and the contracted blade above forms the handle. None of the connecting tissue is removed, but it gradually wears away, leaving the naked stiff fibers (Pl. LVII, figs. 6, 7). These brushes are seen in all the small markets of western Mexico, and are even found in the great market house in the city of Guadalajara.

EB No. 5. A spinner or twister used by the Cora Indians in making ropes of agave fiber.

This was the commonest spinner I saw, and is composed of 2 pieces of wood (Pl. LI). Of these one is flattened and somewhat wedge-shaped, about 3 dm. (1 foot) long, and considerably heavier at one end than the other. At its smaller and lighter end is a notch, and just below this notch is a small hole. The second piece consists of a round stick about 3 dm. (1 foot) long, which is small enough to work freely in the hole of the first piece. At one end is a small knob which prevents the heavier piece from coming off.

In making thread or twine two persons are employed. One of them sits with the mixed fiber in his lap or at his side, while the one who does the twisting stands. Some of the fiber is fastened about the notch of the first piece described, which is then rapidly revolved about the second piece as an axis. The person who is doing the spinning retreats as the thread lengthens until the required length is reached.

In making ropes the process thus far is the same. This thread is now doubled and the twisting is continued and then again doubled until a rope of the proper size is obtained. Sometimes both persons use instruments, twisting, of course, in opposite directions. These spinners are made of various materials, such as bamboo, oak, etc.

Another instrument of this kind was composed of a stick about 3 dm. (1 foot) long, with a notch near one end, as in the above. Below the middle was a small wheel 2 dm. (8 inches) in diameter which had a toothed margin. This stick is made to revolve rapidly by striking the wheel, which is made fast to the axis, with a rude bow strung with rawhide.

EB No. 17. An instrument used in making a coarse thread from agave which I secured at the hacienda of San Juan Capistrano, in western Zacatecas.

This was a combined spinner and reel (Pl. LII, fig. 3). It was obtained of a Huichole Indian, although similar ones are used by the Mexicans themselves. This instrument has the advantage over the one described above of permitting one person to feed and spin the thread at the same time and for an indefinite period, for as soon as the thread becomes too long to handle it is wound about the reel. The instrument is used in making a coarse thread or string employed in making the hand bags so much carried in Mexico.

The instrument is composed of two upright strips of a bamboo stem 22 and 25 cm. (9 and 10 inches) long, respectively. These are joined together by two small strips 10 cm. (4 inches) long about one-fourth the distance from each end, and there fastened by small strings. This forms the reel proper. To make a spinner of this a notch is cut near the end of the longer upright piece and a small stick about 12 inches long is used as the axis of the spinner, which is put through the two upright pieces about one-third of the distance from the top. One end of this stick is tightly wrapped with a small string made of agave fiber, and a small leather washer is placed between this and the reel. To make the thread, a portion of the mixed fiber is fastened about the notch of the reel, which is then revolved rapidly with one hand and the fiber fed with the other. The reel I obtained was in use, and the thread and all the mixed fiber in the process of spinning was purchased with it.

The fiber here used is from one of the most widely distributed agaves in western Mexico. It is called "tapemete," and is probably *Agave vivipara*.[1] The cleaned fiber is about 6 dm. (two feet) long, and, although coarse, is pliable and strong. For making the pocket bags a coarse double thread is used. The needle is made of a small piece of bamboo about 12 cm. (5 inches) long.

EXPLANATION OF PLATES.

PLATE L.—Fig. 1, a bag made from agave fiber; fig. 2, a bunch of agave fiber used as a wash rag.

PLATE LII.—Fig. 1, a bunch of *Agave vivipara* fiber; fig. 2, the same being worked into a small bag, together with bamboo needle; fig. 3, a spinner and reel used with this fiber.

MALVACEAE.

Ceiba spp.

Tree cotton, a fiber obtained from the seed pods of several species of Ceiba, is gathered by the Mexicans along the west coast and used for stuffing pillows, etc. At the little village of Concepcion, Sinaloa, I saw two large trees of *Ceiba casearia* Medic., one being about 27 dm. (6¾ feet) in diameter and evidently a very old tree. This species is supposed to have been introduced into Mexico. A native species, *C. grandiflora* Rose, more common and widely distributed, is said to furnish cotton which is used like that from the above species. (EB No. 1, tree-cotton fiber from *Ceiba casearia* Medic.)

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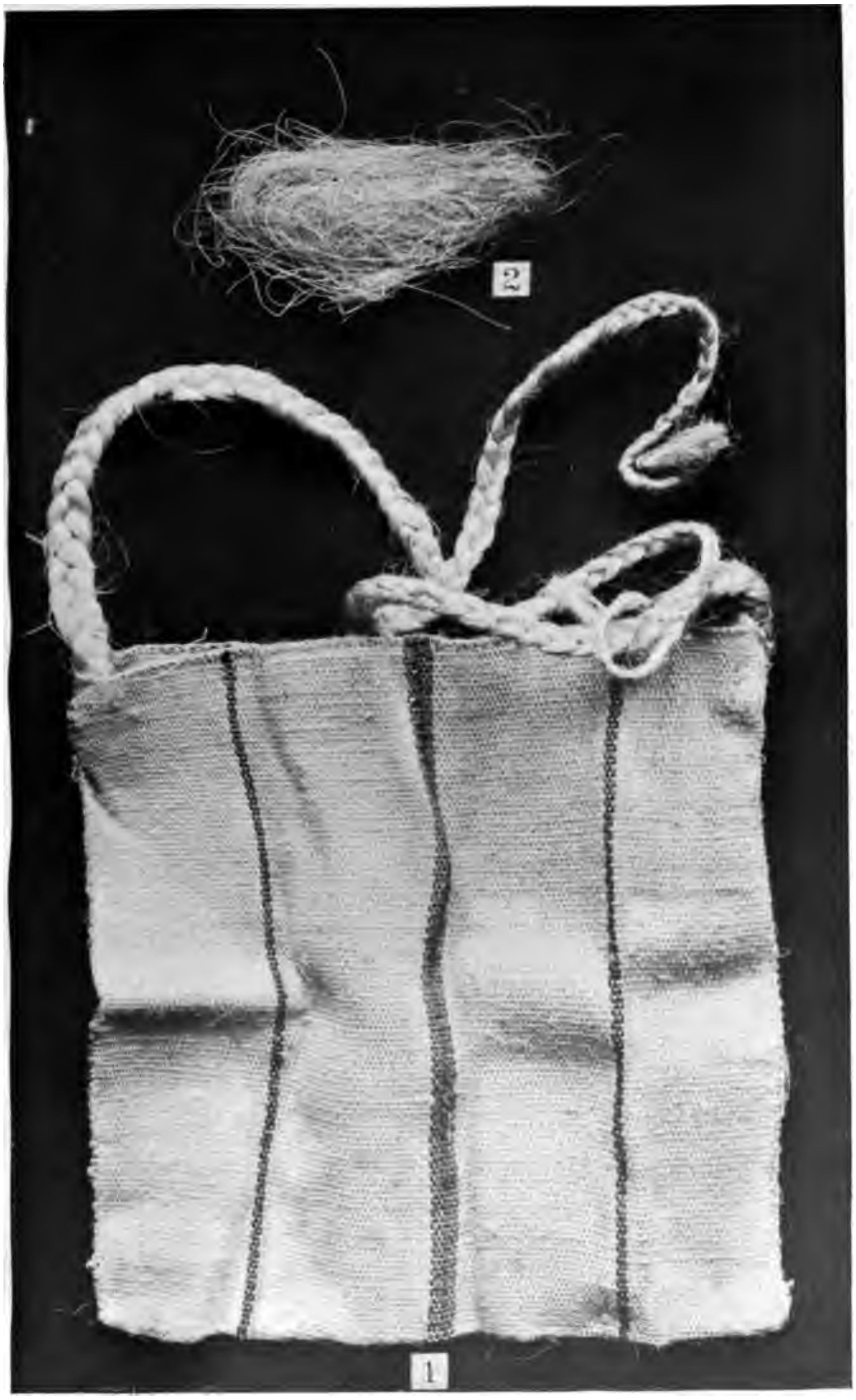
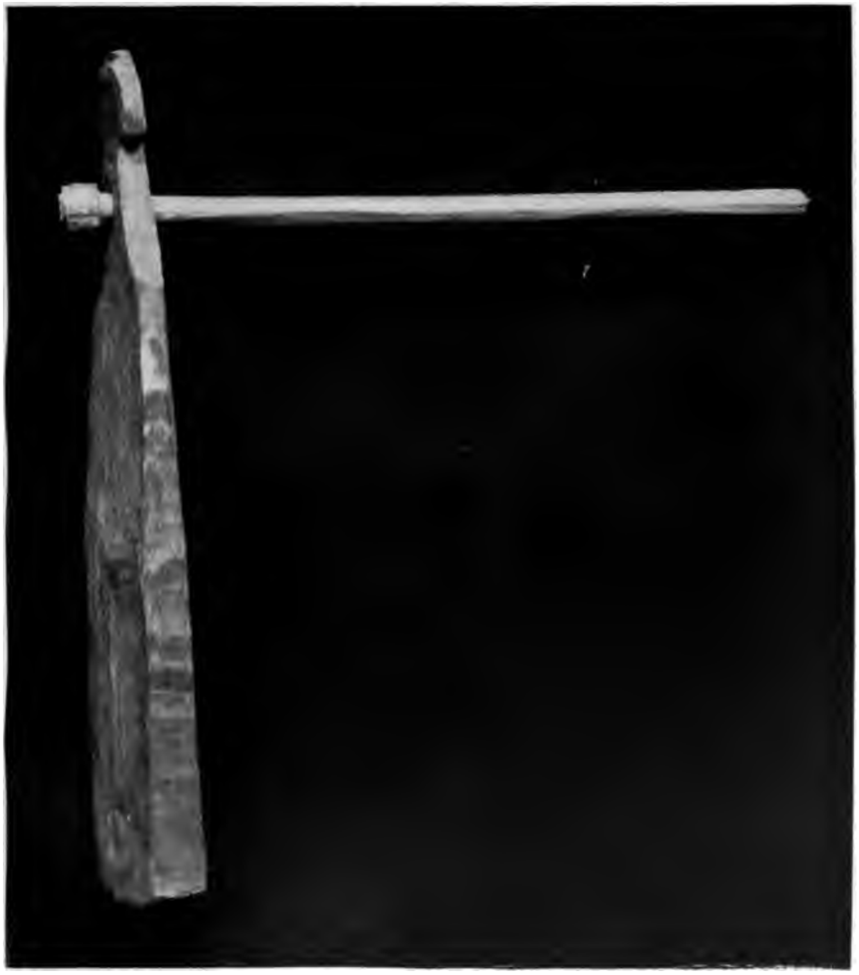
[1] See above, p. 246.



ARTICLES MADE FROM IXTLE FIBER.



A FIBER TWISTER.

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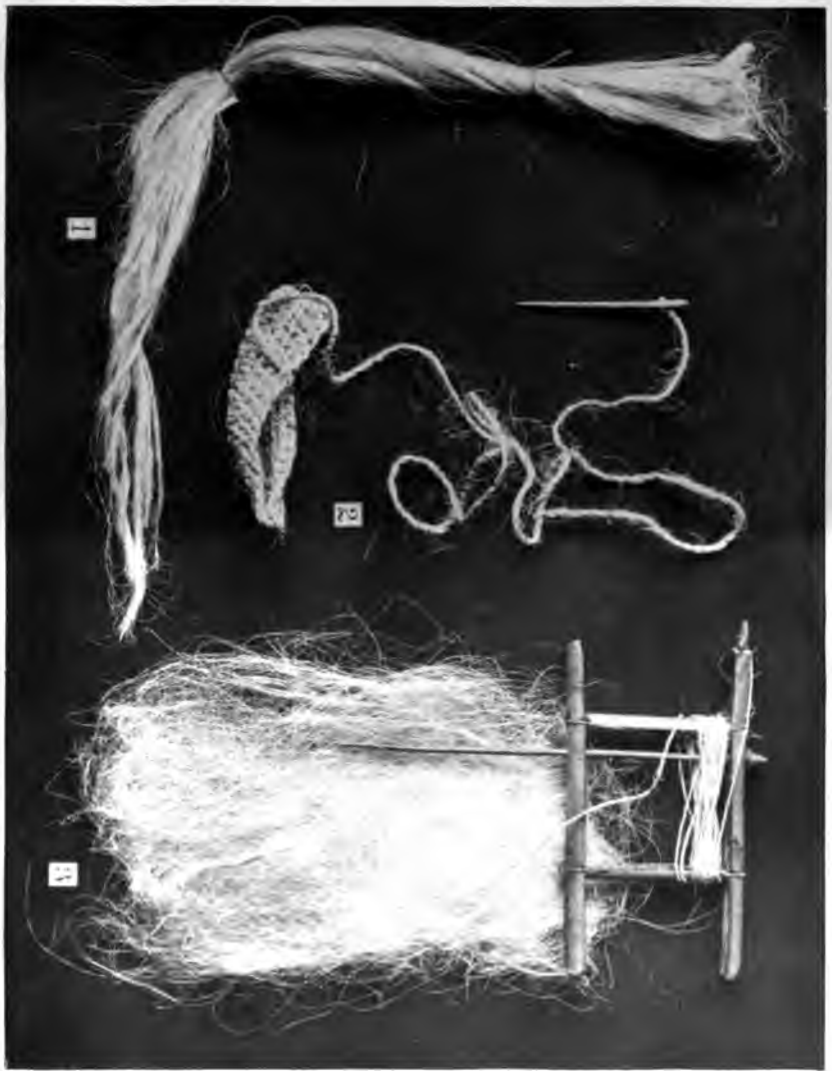
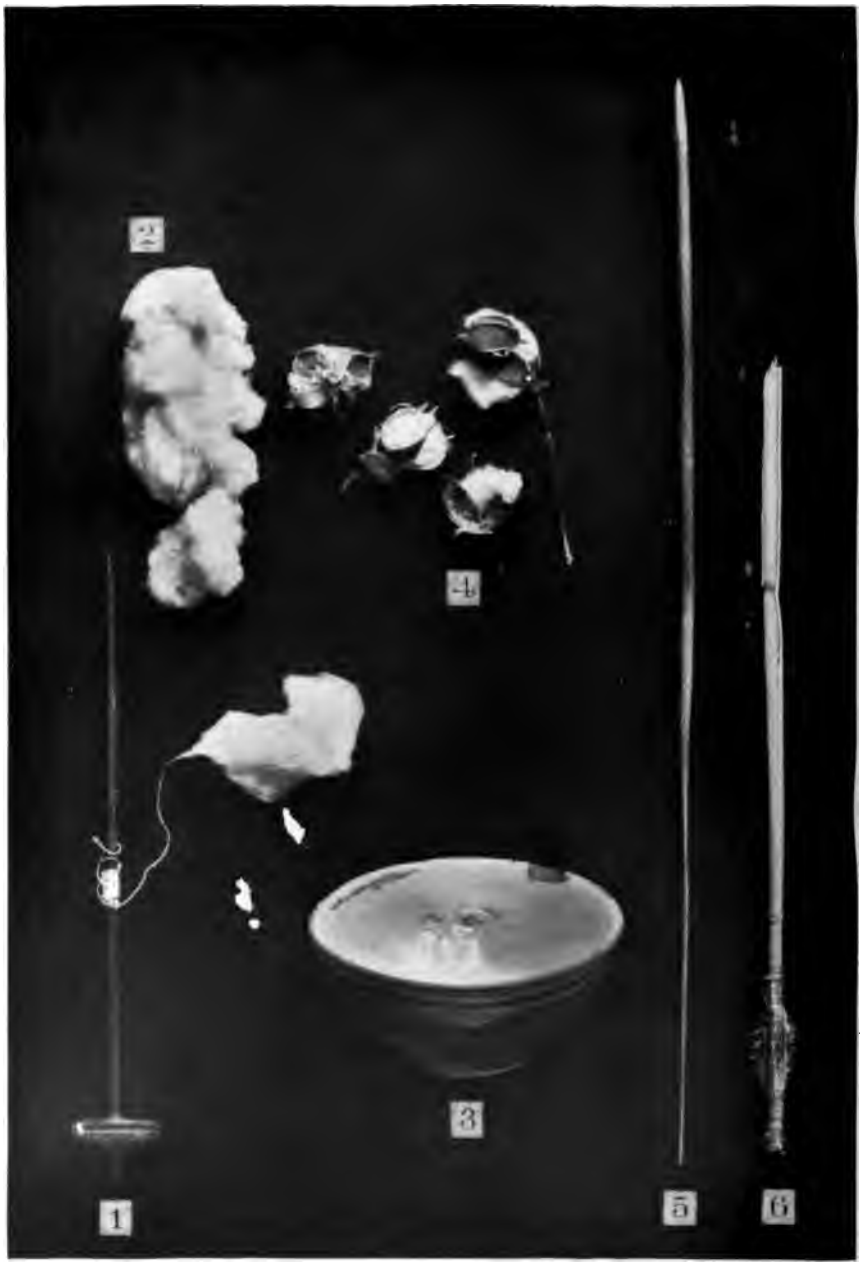
PLATE LII.



AGAVE FIBER AND MANUFACTURING IMPLEMENTS.



COTTON FIBER AND IMPLEMENTS.

Gossypium barbadense L.

This is a large, bushy shrub, 24 to 36 dm. (8 to 12 feet) high. It is grown in many parts of Mexico and is seen in yards and gardens. I saw shrubs at Guaymas, in the Sierra Madre, at Bolaños, etc. My specimens came from Bolaños, September, 1897 (Herb. No. 3697).

Mr. Hemsley, in the Biologia Centrali-Americana, states that in Mexico the species is "cultivated and wild, probably indigenous in America." In the National Herbarium we have only three other species, and these all cultivated. They are the following:

Palmer's No. 10, from the State of Jalisco.

Palmer's No. 116, from the State of Coahuila.

Charles K. Dodge's No. 70, from near Monterey.

At Bolaños and other places the uncleaned cotton is gathered and sold in the little stores. The women buy this, clean out the seeds, and spin it into thread.

For this purpose they use a rude spinner (Pl. LIII), consisting of an upright shaft or spindle 2.5 dm. (10 inches) long and less than 6 mm. (¼ inch) in diameter, somewhat tapering toward the top. This spindle is usually made from an old Indian arrow, and my specimen appears to be of Brazil wood. Near the bottom of the spindle is a circular disk or whorl 3.8 cm. (1½ inches) in diameter, made of some heavy wood (in my specimen said to be ironwood), somewhat rounded below.

The thread is made in this manner: An ordinary clay bowl 12.5 cm. (5 inches) in diameter is held in the lap. The thread is begun by fastening a piece of the cotton to the middle of the spindle. The spindle is then revolved rapidly in the bowl with the right hand, while the cotton is "fed" or supplied with the left hand. As the thread lengthens it is wound around the spindle and the work of spinning continued. The women become very expert in spinning and it is very interesting to watch them.

Specimens were obtained as follows:

EB No. 54. A bowl in which the spinner is twirled.
EB No. 55. The cotton spinner called "trompa."
EB No. 56. The thread and raw cotton.
EB No. 57. The cotton with seeds as sold in the stores.
EB No. 58. The cotton bolls.
Herb. No. 3697. The cotton plant.

EXPLANATION OF PLATE LIII.—Fig. 1, cotton spinner with thread attached; fig. 2, clean cotton; fig. 3, bowl for holding the twister; fig. 4, cotton bolls; figs. 5, 6 parts of Huichole arrows used in repairing the cotton spinner.

CUCURBITACEAE.

Luffa cylindrica (L.) Roem. ESTROPAJOS.

The vegetable sponge was seen only in cultivation, where it grows as a tall vine. The fruit is about 3 dm. (12 inches) long, and the bright yellow flowers are nearly 10 cm. (4 inches) wide.

The plant is sometimes cultivated for the sponge-like tissue of the fruit, which is left ready for use as a sponge by the natural breaking away of the epidermis.

The following material illustrates this plant:

Herb. No. 1682, flowers, leaves, etc. (EB No. 82, the mature fruit showing the interior fiber beneath the broken epidermis.)

BRUSH AND BROOM PLANTS.

Many curious brushes and brooms are met with. In the accompanying illustrations some of these are shown. Those made of agave leaves and fiber (Pl. LVI), used for the hair and for scouring and whitewashing, are spoken of on pages 248, 249. Fly brushes are made from palm leaves (Pl. LIV, fig. 1), one of which I obtained as a specimen. Brooms are also made of palm leaves, being supplied with bamboo handles. Other brooms are made out of the stems of various grasses, such as species of *Stipa* and *Muhlenbergia* (Pl. LIV, fig. 2). These stems are 9 to 10 dm. (36 to 40 inches) long, and are tied together with strips of yucca leaves (Pl. XXXVIII) called "isote."

EXPLANATION OF PLATES.

PLATE LIV.—Fig. 1, a fly brush made from the leaves of an undescribed Sabal which is very common on the west coast; fig. 2, a broom made from the stems of a grass, probably a Stipa.

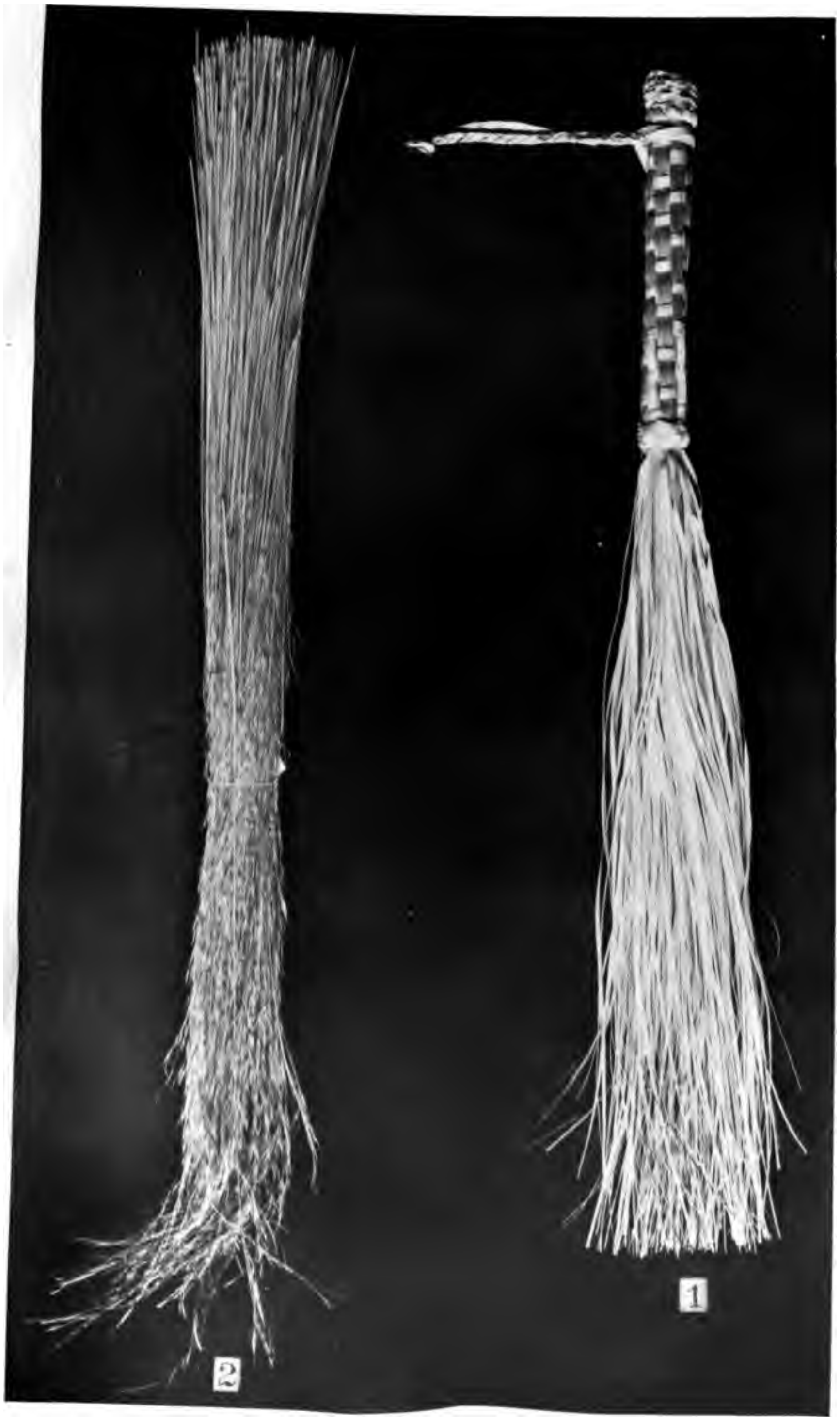
PLATE LVI.—Figs. 1 to 5, several types of hairbrushes made from various agave leaves; figs. 6. 7, scouring brushes made from *Agave viripara;* fig. 8, a palm leaf (*Sabal* sp.) brush; fig. 9, a whisk of grass roots (*Epicampes* sp.).

GRAMINEAE.

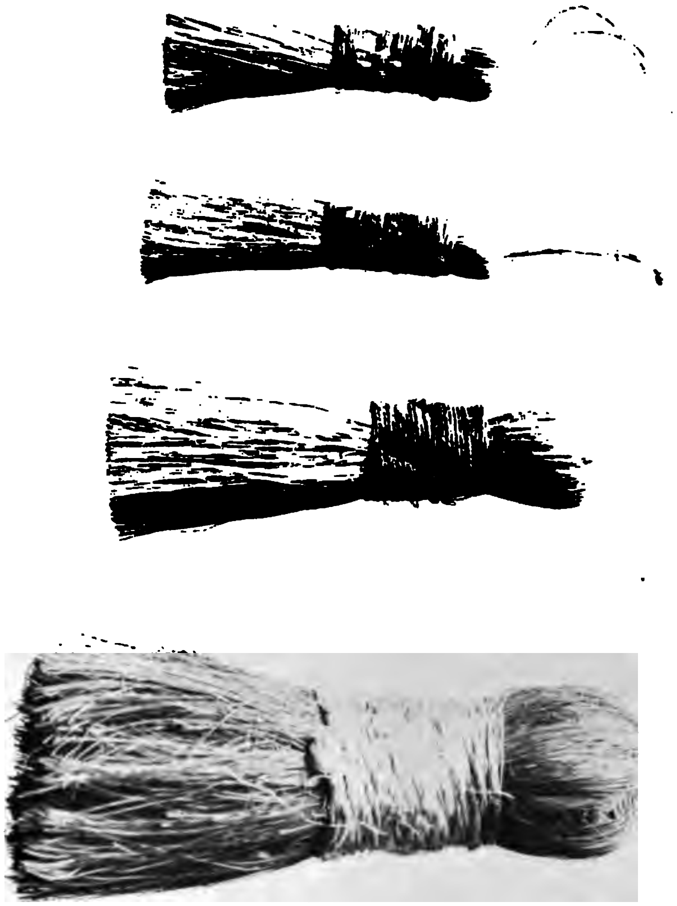
Epicampes macroura Benth.

"Raiz" (meaning "root") is largely exported from Mexico, as well as extensively consumed at home. It is usually exported into the United States as "broom root;" it is also sometimes called Mexican broom root, Mexican whisk, and sometimes erroneously "rice roots." These roots are from grasses, chiefly *Epicampes macroura*, sometimes called *Crypsinna stricta*. This is a native of the high mountains of Mexico, reaching an altitude of 3,908 meters (12,500 feet). It is largely dug in the States of Mexico, Michoacan, Queretaro, and Puebla. The roots, in Mexico, are chiefly used for making a rude brush or broom much esteemed and found for sale in all the large markets. I bought one of these in Guadalajara, which is about 15 cm. (6 inches) long and 5 cm. (2 inches) in diameter.

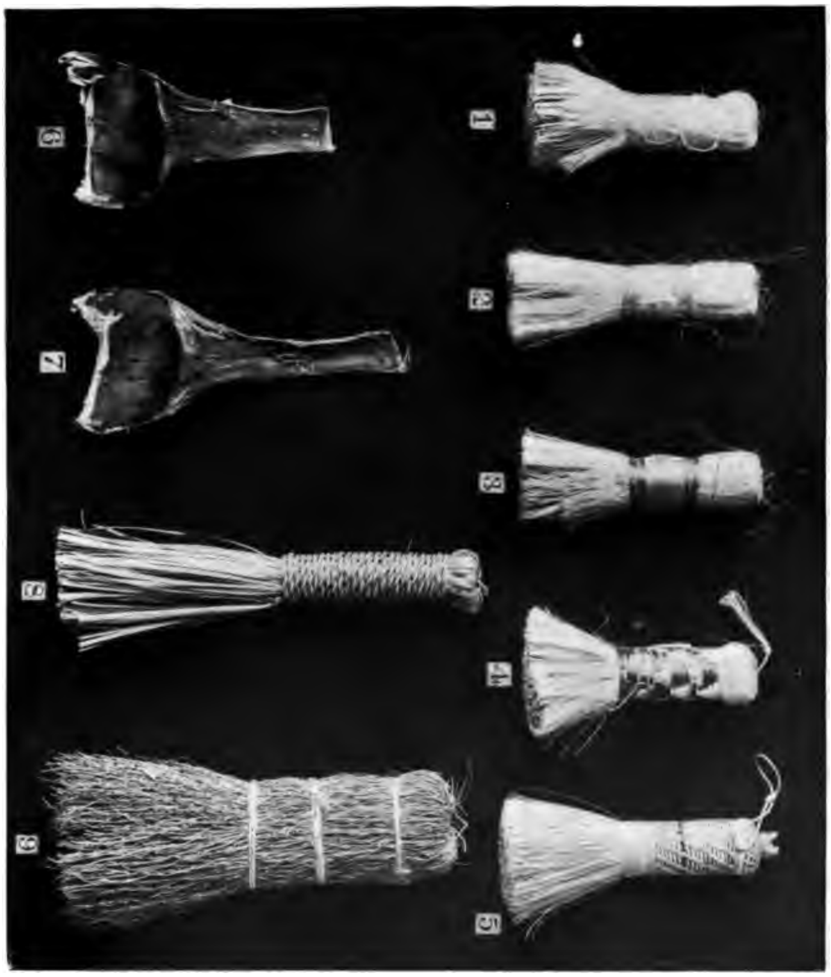
This material has been largely imported into this country, both in a raw state, then duty free, and in a partially manufactured state, subject to duty. In the latter condition it appears, under the name of rice root, in the Treasury report of 1878, and thence onward with intervals to 1891; but the amount is lumped with that of broom corn. As raw material it appears in 1884 and continues with intervals to the present date, as shown by the table below, assuming the name of "broom root" in 1893. The importation, which exceeded a value of $125,000 in 1886, appears to have fallen to nearly none in the period from 1888 to 1893. Since then the average annual value has been



BRUSHES OF PALM LEAF AND GRASS.

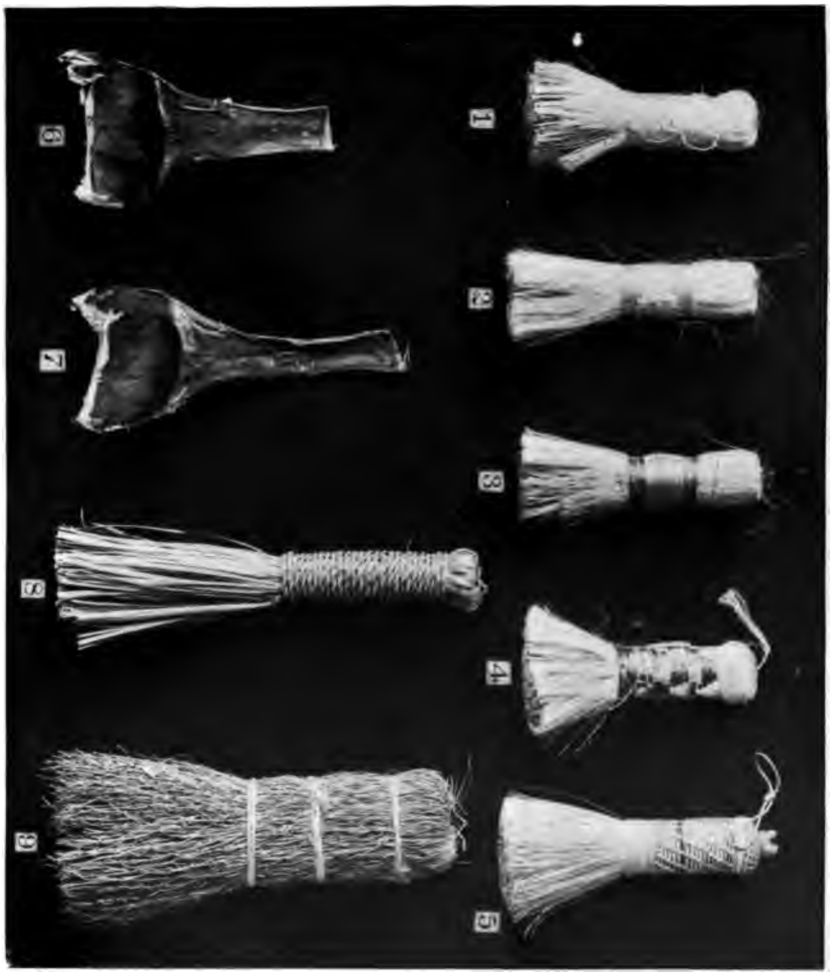


HAIRBRUSHES MADE FROM TAMPICO FIBER.



BRUSHES MADE FROM SEVERAL KINDS OF FIBER.

PLATE LVI.



BRUSHES MADE FROM SEVERAL KINDS OF FIBER.

Jatropha platyphylla Muell. SANGRE GRADO.

This species, called by the same name as the preceding, is also used as a hedge plant. It has a large peltate leaf and an open inflorescence. We have no specimens like it in the National Herbarium.

CACTACEAE.

Cereus pecten-aboriginum Engelm.

The most interesting of the hedges to the botanical traveler are those made of the great cereus (*Cereus pecten-aboriginum*) of western Mexico, which is perhaps the real giant of the cactus family (Pls. LVII, LVIII, and fig. 32). It often reaches 15 and 20 meters (45 to 60 feet) in height, and sends up a multitude of long naked branches. The branches are cut off into lengths of 18 to 30 dm. (5 to 9 feet) and transplanted into rows closely set together, forming an almost impenetrable break against all kinds of stock. These branches finally take root and grow slowly, rarely sending off short side branches, and ultimately flowering and fruiting near the tops. The large fruits are covered with long yellow bristles set close against the trunk, and furnish rich granaries stored with many seeds for the birds.

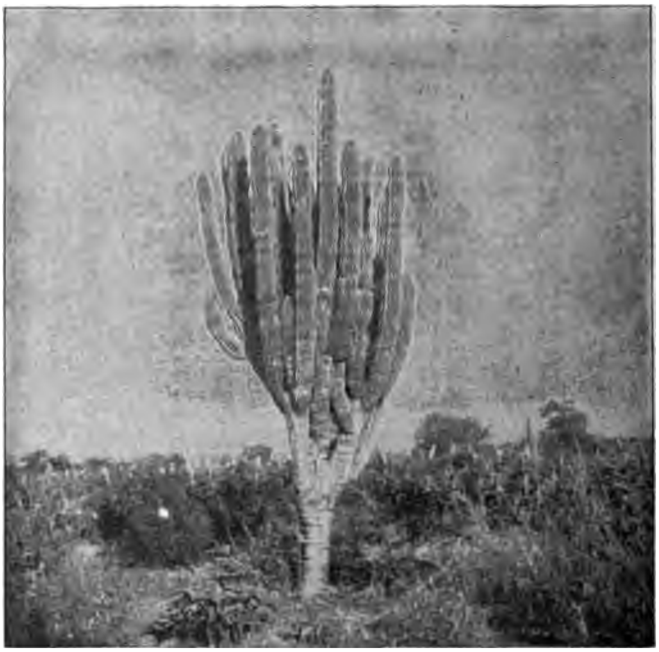
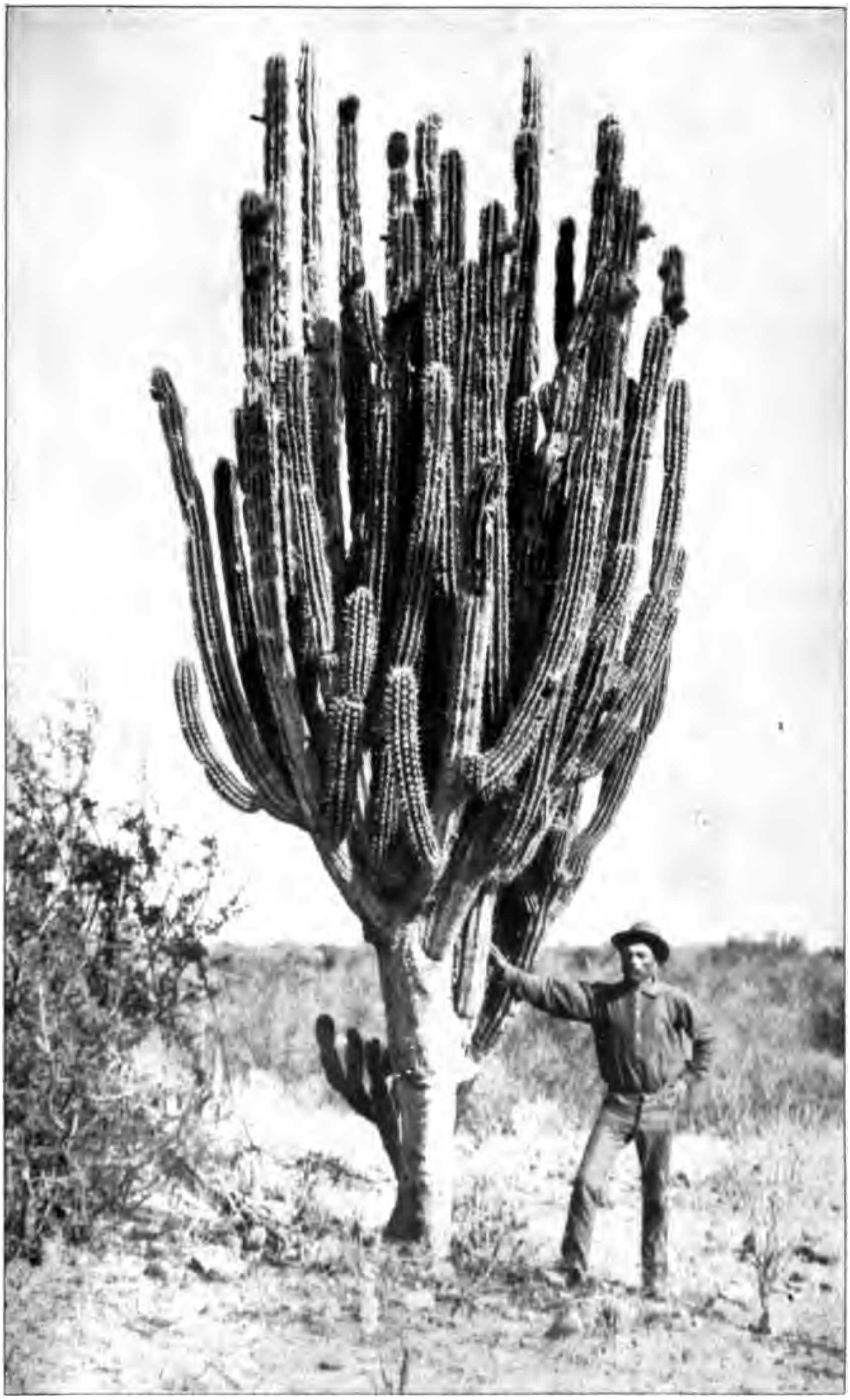


FIG. 32.—*Cereus pecten-aboriginum* Engelm.

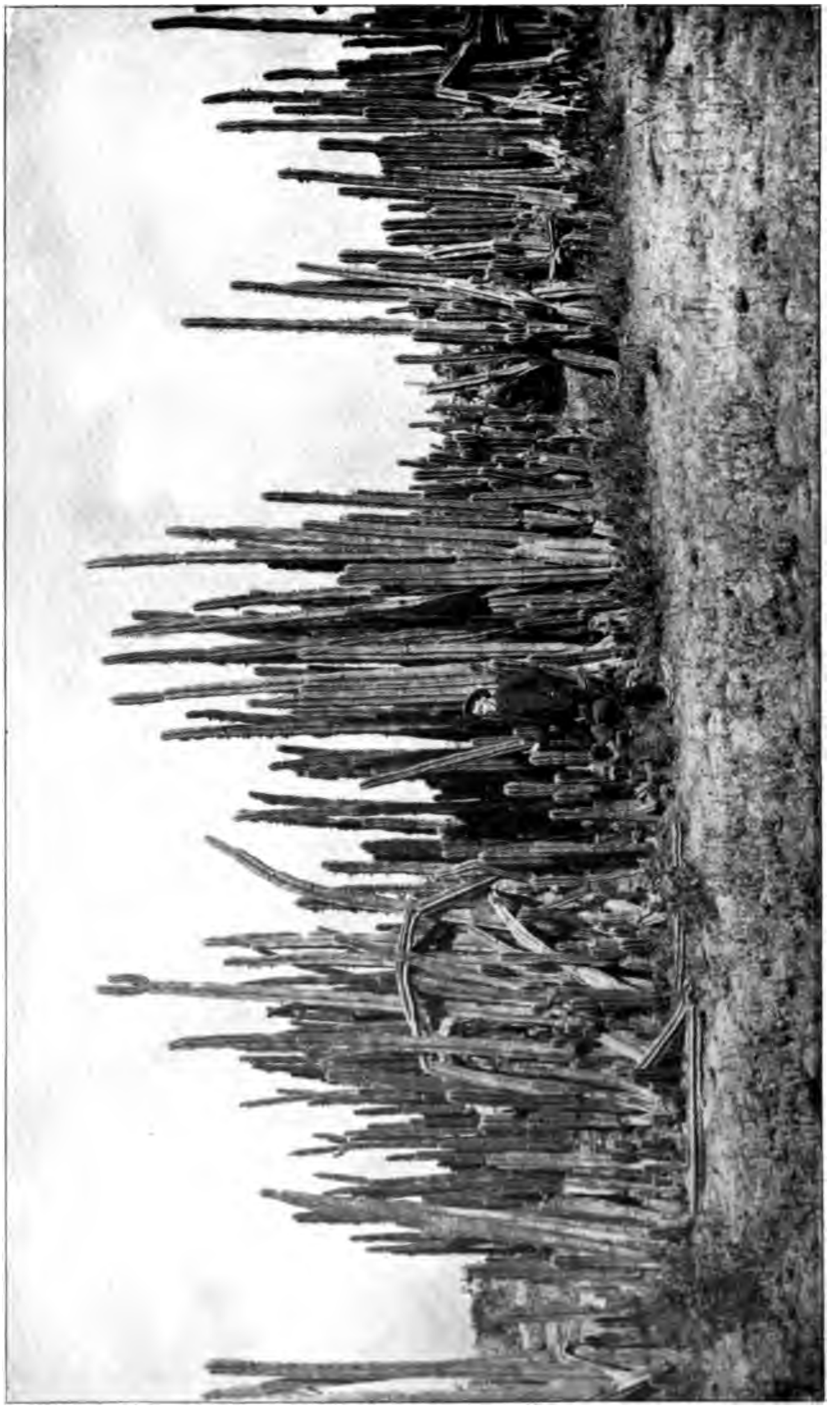
Dr. Palmer tells me that *Cereus thurberi* of northern Mexico is also used for fences. In central Mexico another of the columnar cacti, which they call "organos" (Pls. LIX, LX), is so used. This is *Cereus marginatus* DC. (?)

Opuntia spp

Several species of Opuntia are grown for boundary hedges.

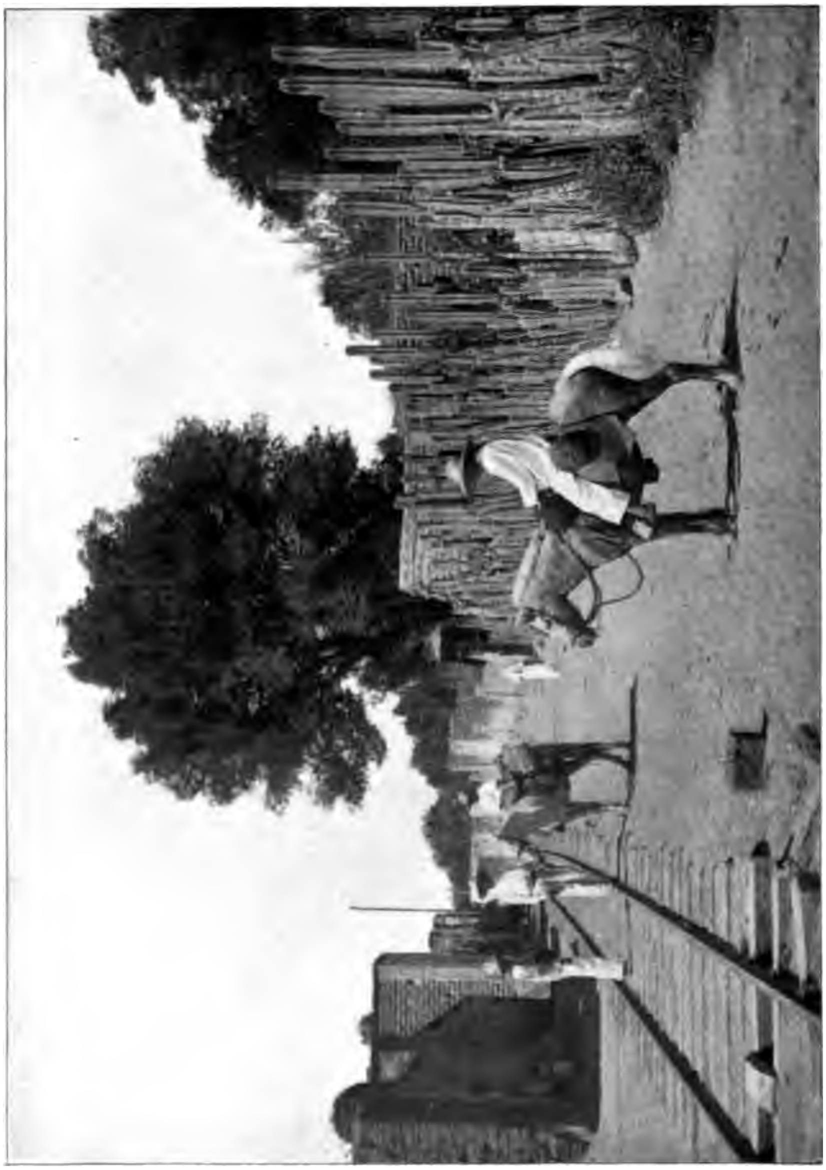


CEREUS PECTEN-ABORIGINUM Engelm.



ORGANO (CEREUS MARGINATUS DC. (?)), USED FOR FENCES NEAR THE CITY OF MEXICO.

PLATE LX.



Organo (Cereus marginatus DC. (?)), used for fences near the City of Mexico.

OTHER FAMILIES.

Agave spp.

The large pulque agaves are planted in close rows, and form very effectual hedges.

Bromelia spp.

Bromelia pinguin (?) and perhaps other species are used for hedges, especially as boundary lines between estates.

Erythrina spp.

Several species of Erythrina, such as *E. lanata* and *E. flabelliformis*, are in common use for hedge fences.

Fouquieria spinosa H. B. K.

Fouquieria spinosa, so common about Guaymas, is sometimes used as a hedge plant.

Verbesina pinnatifida Cav.

Verbesina pinnatifida, which often grows to the height of 3 to 4 meters (9 to 12 feet), is a common fence plant, either grown alone or in connection with *Jatropha curcas*.

PLANTS YIELDING WOOD.

Neowashingtonia sonorae (Wats.) Rose.[1]

At Guaymas a few trees remain of the rare *Neowashingtonia sonorae*, but most of them have been cut out and used as rafters for houses. It is said to be a very durable wood. A considerable number of these trees are still to be seen at La Paz, Lower California.

Salix sp.

In the markets at Colotlan rude shoe lasts, said to be made of willow, were for sale. (EB No. 23.)

Guaiacum coulteri A. Gray. GUAYACAN.

Guayacan is one of the commonest and most useful woods about Guayamas. It is extremely hard and makes a fine firewood, yielding a great amount of heat. When burnt it gives off a strong, disagreeable, resinous odor which prevents its use as a house wood. It is much used on the Sonoran Railroad as a firewood for engines. It is used in many ways, especially where great strength is required, as in the making of cogwheels, etc. According to Dr. Palmer it has certain medicinal properties.

Hippocratea sp. BEJUCO COLORADO.

The bejuco colorado is a very useful vine employed all along the west coast in the place of ropes, nails, etc. When green it is very pliable and can readily be tied into all kinds of knots, but when dry it becomes fixed and strong (Pl. LXI, fig. 1). It is employed in fastening together the framework of huts or in tying down the roofs. In fence building it is employed to bind the various upright pieces together. It also takes the place of the ordinary rope clothesline. One of these clotheslines which I measured was 18 meters (60 feet) long and showed little or no variation in diameter throughout its length. This plant grows in the foothills of the Sierra Madre, where the people from the coast go to obtain it when needed in their simple industries. Here it was I found the plant and collected botanical specimens of it, discovering to my surprise that it is new to science.

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[1] *Washingtonia sonorae* Wats. Proc. Am. Acad. **24**: 79. 1889.

Guazuma ulmifolia Lam. GUAYACAN.

In the collection is a ladle said to be made from "guayacan," a name also applied to the wood of *Guazuma ulmifolia* (Pl. LXI). This wood is much employed in making small articles of everyday use. This ladle has a round bowl 9 cm. (3½ inches) in diameter and 2.5 cm. (1 inch) deep at the lowest point, and a handle nearly 4 dm. (16 inches) long. It is typical of the ladles which in many of the interior parts take the place of ordinary spoons or any other similar table utensil. Knives and forks are never seen outside of cities and towns.

Chocolate sticks made from Madroño wood (*Arbutus* sp.) are very common. (EB No. 69. Ladle said to be made from "guayacan," the wood of *Guazuma ulmifolia.*)

EXPLANATION OF PLATE LXI.—Fig. 1, wooden ladle; fig. 2, chocolate stick; fig. 3, bejuco colorado.

Randia sp. PURO CECILLIA.

Shoe pegs as used at Acaponeta are made from the wood of a species of Randia; this is a small bush. (EB No. 4, pegs bought at Acaponeta.)

MISCELLANEOUS USEFUL PLANTS.

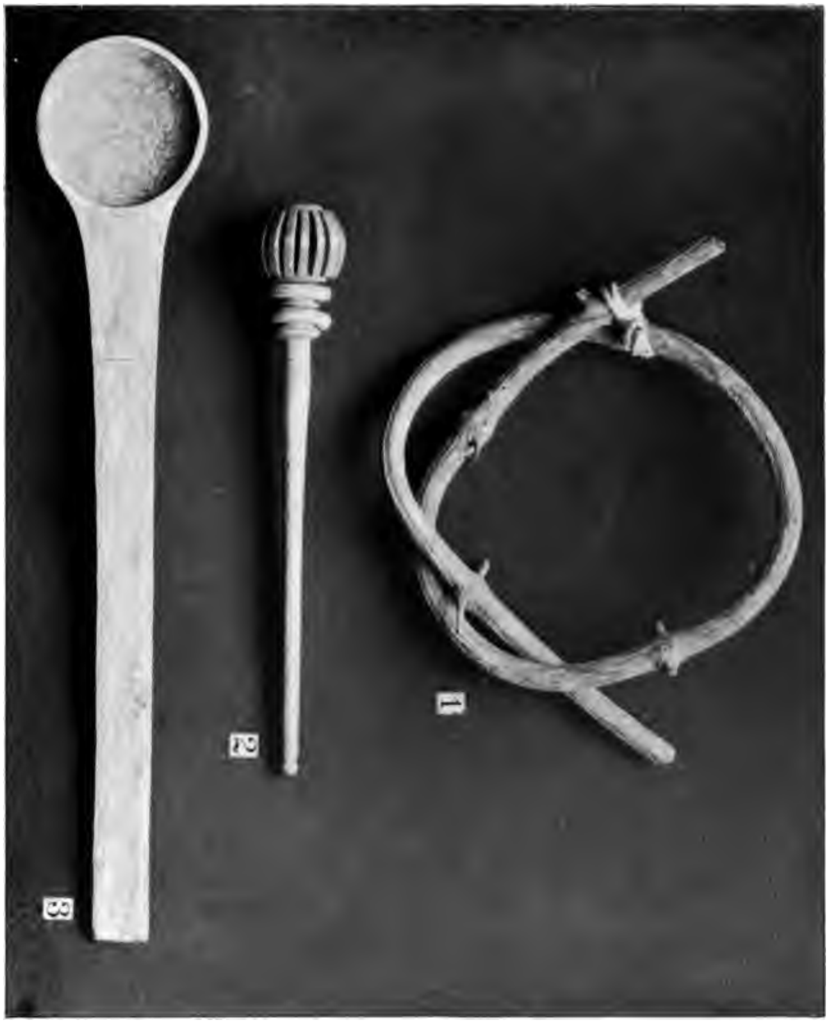
Bessera fistulosa (Herbert) Pritz. ARETE.

The liliaceous genus Bessera, though usually considered monotypic, may really be composed of several species. One of these, probably *B. fistulosa*, is very common on the foothills on the west coast, reaching up to 2,500 feet altitude. It has very pretty red flowers and is quite a favorite with the country people, who often use it to decorate the altars in their churches, etc. Their earrings are sometimes patterned after it.

Other wild flowers are gathered to cover arches which are placed over the doorways of the churches. Among plants so used which I recognized are *Zinnia linearis* and *Tagetes lucida*. The churches of the Cora Indians are the most gloomy houses one can imagine. They are usually made of rude stones, with a filling of mud, and are without windows. The roofs are thatched with mountain grass (*Epicampes* sp.) laid upon bamboo stems. This roof often extends forward several feet over the front entrance. Here are found several church bells which are hung by means of vines (probably *Hippocratea* sp.) The bells have no clapper, and are reached by a ladder and then rung by being struck with a stone or some other solid object.

Even the Spanish bull fight has some botanical interest. The wreath with which the victor is decorated is made of branches of trees with bright, shining leaves. I obtained specimens from one at Guaymas, which was made of leaves from an undetermined tree.

PLATE LXI.



WOODEN ARTICLES.

The note may be thrown in here that although more of the names of Mexican towns have a religious derivation than any other, yet a great many towns and hamlets, especially of the smaller ones, are named for plants. Among the first class one finds such names as Jesus Maria, Pedro Paulo, Concepcion, and hundreds of names with the prefixes "San" and "Santa." The following places named for plants were along my route: "Colomas," named for a little Arum-like plant of the neighborhood; "Tamarindo," named for *Tamarindus indica*, a widely introduced and highly prized tree; "Aguacote," named for the well-known fruit of the same name, *Persea gratissima;* "Palmareta," named for a small palm (Sabal) of that region; "Mesquitic," named for a Prosopis. Other such names for towns of this region are "Nanches" (*Byrsonima crassifolia*), "Ocote" (Pinus), and San Francisco Mesquital.

Acacia spadicigera Cham. & Schlecht.

Among the decorations used by the Cora Indians to ornament their quivers are the large thorns of *Acacia spadicigera.*

These thorns are cut into lengths of 2.5 cm. (1 inch) or more and fastened by means of agave strings into great clusters of 50 or so. My specimen (EB No. 73) came from one of these clusters.

Hura crepitans L. HABA.

This is a large tree belonging to the order Euphorbiaceae. The Mexicans use its sap to poison or stun fish so that they may be more easily caught. A series of Vs, one above the other, are cut with a machete on the side of a tree. The sap oozes out from the wounds, runs down to the apex of the V and joins with the contents of the one below, and so on through the series, the entire contents being caught in an earthen vessel placed at the base of the tree. One rarely sees a tree without these V-shaped scars.

South American Indians also use the sap of this for killing fish.

This tree is known under a great many names, among which are the the following: In the Republic of Colombia, "l'aguapan," "acupa," and "hibillo;" in Guiana, "soliman;" among certain South American Indians, "sablier;" in Panama, "javilla;" in Guatemala, "tetereta;" at San Ignacio, "pepita" and "habilla." It is also called "monkey's dinner bell" and the "sandbox tree." In the State of Sinaloa, on the west coast of Mexico, where I saw the tree, it is called "haba" or "hava," and in other places in Mexico "quahtlatlatzin." Here it is planted along the roadsides, often in long rows beside the fences. Occasionally trees were seen in out-of-the-way canyons, appearing as if native; but this part of Mexico has so long been inhabited that seeds may readily have been carried from cultivated trees of the neighboring region.

Cactaceae.

Considerable has been written of a more or less fanciful character regarding plant worship among the Mexican Indians. While I obtained no special information along this line, I succeeded in obtaining specimens which have enabled me to identify accurately some of the plants reported to be used for this purpose. Lumholtz, the Mexican traveler, says that "all the small cacti are regarded with superstitious reverence by the Tarahumari [Indians]. They have different properties, the most pronounced of them being to drive off wizards, robbers, and Apaches, and to ward off diseases." They are generically called "hikora," "hikora sunama" being *Areocarpus fissuratus*, and "hikora wanami," *Lophophora williamsii*. In the high Sierra Madre in the Territorio de Tepic I collected specimens of one of these cacti which proves to be *Mamillaria senilis* (Pl. LXII). It is a curious little Mamillaria covered with long white spines, whence the specific name. It has also been made the type of a new genus, Mamillopsis, by Dr. Weber, but as I have seen neither flower nor fruit I am not prepared to pass on its generic position. My specimen is growing in the Botanical Garden at Washington. This seems to be the *"hikora rosapara"* of which Lumholtz writes: "Rosapara is a white and spiny hikora differing from the two already mentioned. It must be touched with clean hands and only by people who are well baptized, for he is a good Christian, say the Christian Tarahumaris, and keeps a sharp eye upon the people around him."

Mr. E. W. Nelson visited the Sierra Madre again in 1898, where he collected specimens and furnished me with the following interesting note:

> The small hook-spined cactus grows on the rocks in the pine forest of the Sierra Madre of northern Durango and southern Chihuahua. It was found at between 6,500 and 9,000 feet altitude. This is one of the sacred plants of the Tarahumari Indians, and I was informed that the Indians who have had little intercourse with the Mexicans can not be induced to touch one of them. The specimens I secured were gathered by a Tarahumari man living on the ranch where I stopped. When I told the Indian to gather the plants from the top of a great rock he hesitated and only did it when I insisted upon his compliance. In pulling the specimen loose he tore out another plant and before descending he raised the fallen plant and replacing its roots in position packed the soil very carefully about it. This little incident illustrates the respect in which these people hold this plant.

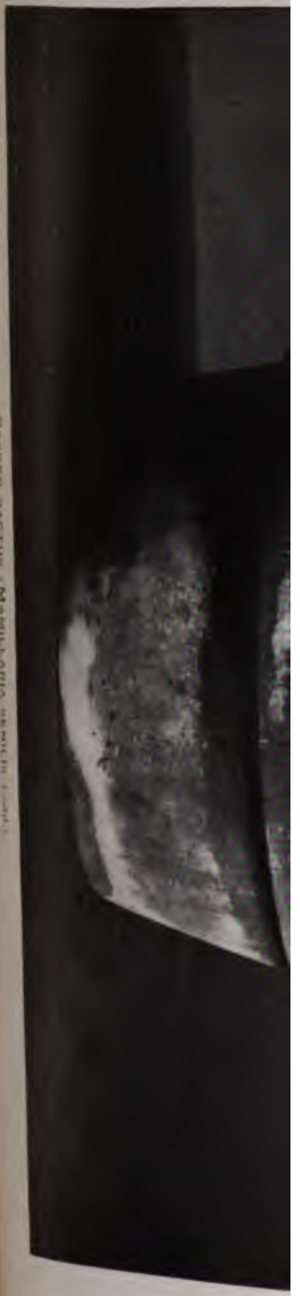
Nicotiana rustica L. TABACO DE MACUCHI.

The tobacco used by the Cora Indians is obtained from *Nicotiana rustica*, which they call "tabaco de macuchi." It is grown in the hot river valley near the little Indian hamlet of San Blascito, Tepic.

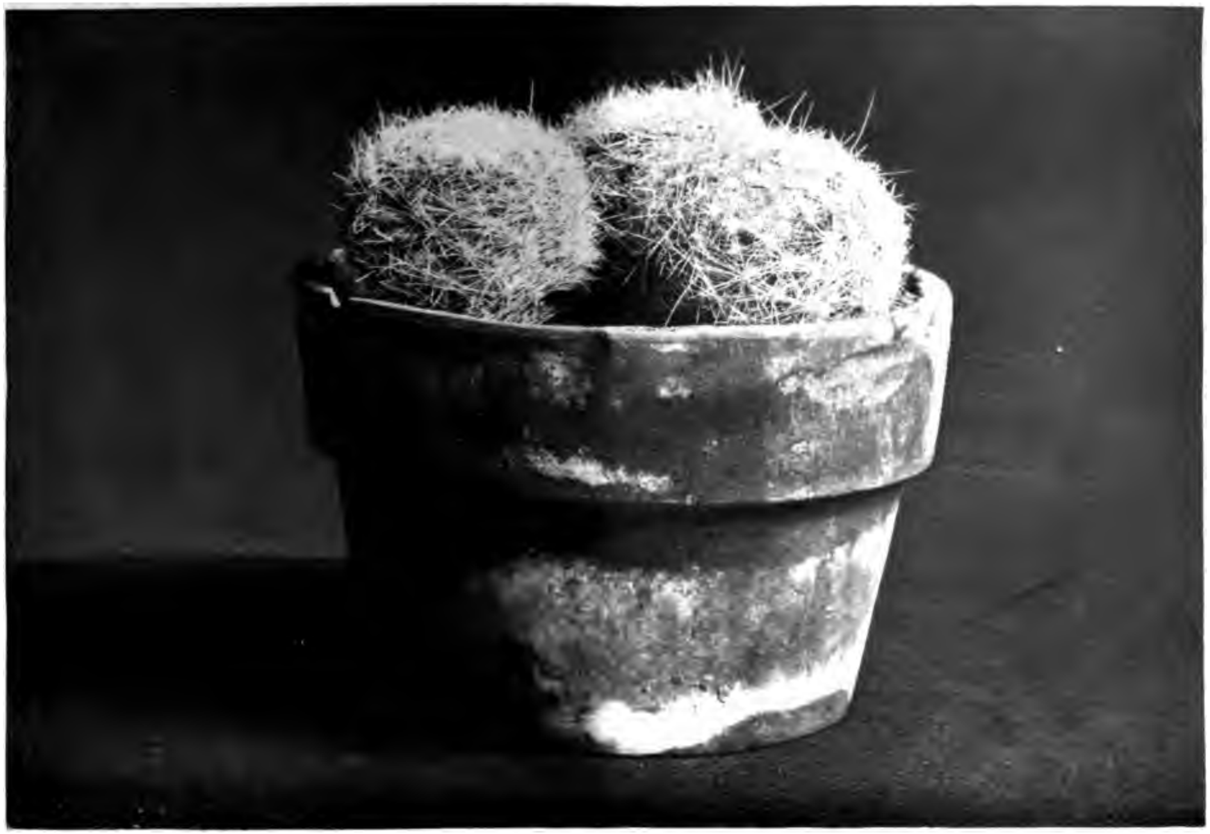
Crescentia alata H. B. K. TECOMATE.

This is one of the most interesting trees which was seen on the west coast of Mexico. It is peculiar in fruit, flower, foliage, and habit. While the genus belongs to the Bignoniaceae, the hard, indehiscent, gourd-like fruit and the wingless seeds are opposed to our usual ideas of this order. The large brownish flowers are borne on the old wood, often on the largest branches, frequently even low down on the main trunk itself, and thus the fruits look as if they were glued on the sides of the tree. The leaves have a broad, winged petiole, tipped with 3 small leaflets. The branches are usually erect, long, and whip-like.

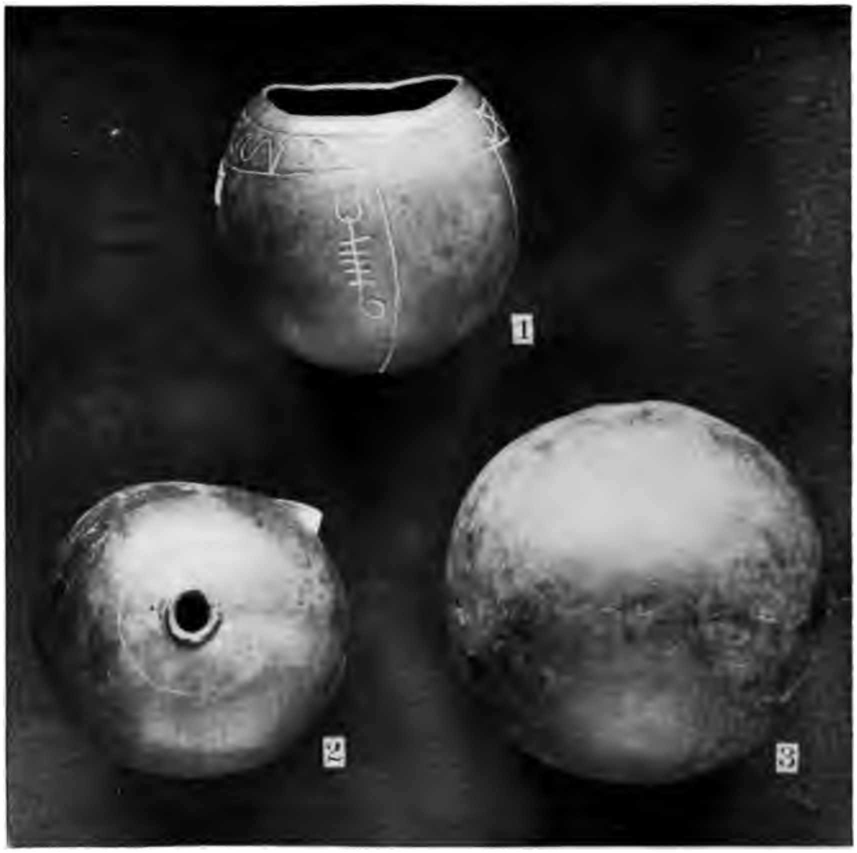
The trees are very common along the coast, often occurring in small groves.



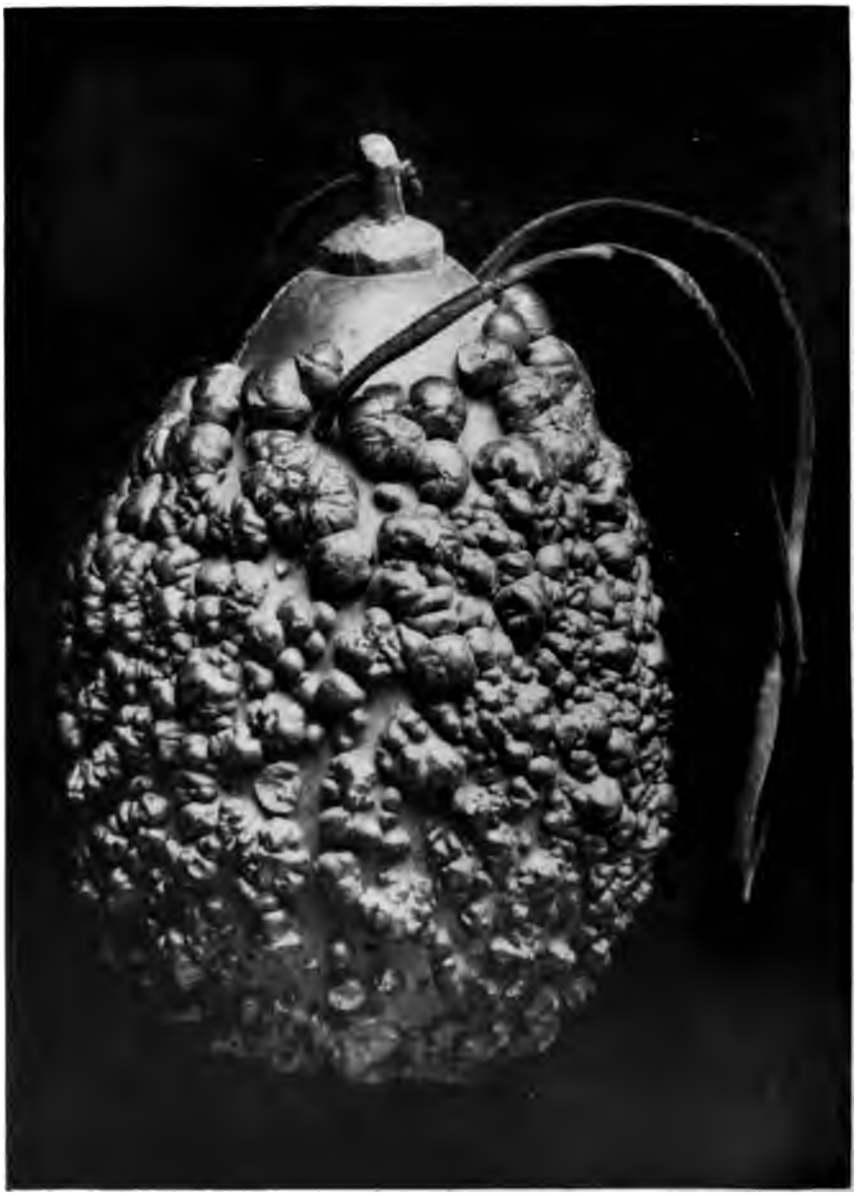
SACRED CACTUS — MAMILLARIA SENILIS



SACRED CACTUS (MAMILLARIA SENILIS [illegible]



VESSELS MADE FROM CRESCENTIA FRUITS.



GOURD USED FOR A WATER VESSEL.

The fruit is used in many ways. Small drinking cups are made by cutting off its lower part (Pl. LXIII). They are most commonly used as a kind of flask for holding mescal. This is made simply by boring a small hole through the base of the fruit the diameter of a lead pencil or a little larger. The seeds and pulp are allowed to dry, but are not taken out. It is then filled with mescal, which they call "vino tecomate." It has a somewhat sweetish taste. One is told that it is much used by miners for lung trouble, but from the quantity which is used and its effects one is inclined to believe that it is taken for other purposes.

These cups and flasks, while sometimes plain, usually have more or less carving upon them, which add much to the expense. I saw one fruit, which was elaborately wrought, that was valued at $1.50. The carving is usually done before the outer shell becomes hard and dry.

Seemann states that the fruit "contains a pulp of a sourish-bitter taste, which is boiled with sugar in its native country, and taken against complaints of the chest." Watson, on the strength of Dr. Palmer's notes, says: "It is cultivated at Guaymas under the name of 'azal,' for shade and for the medical properties of the fruit, which is filled with water and the liquid afterwards taken as a remedy for contusions and internal bruises."

Crescentia cujete, a closely related species, has much larger fruits and these are used in many ways in making dishes, cups, etc.

Besides various botanical specimens of *Crescentia alata*, I obtained the following articles: EB No. 106, a drinking cup from Colomas made from a shell of a fruit. On one side has been cut the form of a scorpion. (EB Nos. 106 and 107, mescal flasks.)

EXPLANATION OF PLATE LXIII.—Fig. 1, drinking cup made from the fruit of *Crescentia alata*; figs. 2, 3, mescal flasks made from the same.

Lagenaria sp.

Besides the curious clay water jar, one may see many water vessels made out of gourds of various shapes and sizes. Almost every countryman carries one of these on the horn of his saddle. The favorite one is about 4.5 dm. (1½ feet) long, with a constriction at the middle and the ends nearly equal. Other forms are also used (Pl. LXIV). (EB No. 20.)

INDEX.

[Synonyms printed in italics.]

Page.

- Abutilastrum 177
- Abutilon andreuxii 171
  - *cinctum* 178
  - crispum 170
  - goldmani 170
  - *holosericeum* 178
  - incanum 170
  - jaquini 170
  - *newberryi* 180
  - reticulatum 171
  - reventum 171
  - sp 171
  - sylvaticum 170
  - *trilobatum* 178
  - venosum 171
  - *wissaduloides* 179
- Acacia berlandieri 194
  - spadicigera 257
  - subangulata 194
- Acalypha phleoides 229
- Achras sapota 222
- Acrocomia sclerocarpa 214
- Acrostichum conforme 146
  - *jamesoni* 146
  - *obtusifolium* 146
  - *piloselloides* 146
  - pilosum 146
  - spathulatum 146
- Acupa 257
- Adiantum *aethiopicum* 147
  - capillus-veneris 147, 228
  - patens 147
  - thalictroides 147
- Aeschynomene 191
  - acapulcensis 191
  - amorphoides 191
  - compacta 191
  - fascicularis 191, 192
  - fruticosa 192
  - palmeri 192
  - paniculata 192
  - petraea 192, 193
  - simulans 192
  - viscidula 191
- Agave, agaves 145, 151, 152, 153, 154, 156, 210, 232, 234, 239, 242, 243, 245, 246, 247, 249, 250
  - *alibertii* 156
  - americana 156, 224, 245, 247, 249
  - atrovirens 245
  - aurea 247
  - brachystachys 233, 234, 237

Page.

- Agave cochlearis 245, 247, 249
  - decipiens 247
  - falcata 245, 247
  - fiber 237, 240, 242-250
    - instruments 244
  - filifera 237, 246, 249
  - geminiflora 245, 247, 249
  - guttata 234, 237
  - heteracantha 233, 237, 239, 242, 247
  - ixtle 243
  - leaves 248, 252
  - lechuguilla 233, 237, 242, 247
  - lophantha 242, 247
  - mexicana 237, 247
  - morrisii 247
  - parryi 237
  - *polianthoides* 152
  - poselgerii 242
  - potatorum 247
  - *potosina* 157
  - *protuberans* 156
  - rigida 239
    - elongata 247
    - sisalana 247
  - *saponaria* 152, 233
  - spp 223, 233, 242, 216, 247, 255
  - striata 241, 245
  - strings 257
  - univittata 242, 247
  - variegata 233, 237
  - vestita 247
  - *virginica* 155, 156, 246
  - vivipara 246, 247, 249, 250, 252
- Agaveae 151, 153
- Agua de cebada 225
- Aguacate 215, 226
  - salad 226
- Aguardiente 224
- Ahuacate 215
  - grande 215
- Ajonjoli 226, 235, 237
- *Aleuritopteris lutea* 148
- *Alibertia* 156
  - *intermedia* 156
- Alligator pear 215
- *Allosorus angustifolius* 149
  - *cordatus* 149
- Almendra 221
- Almonds, Mexican 221
- Aloe sp 228
- Alote 218

Page.
Altea 230
Amole 152, 231, 233, 234, 236, 237
  soap 232
Amolilla 234, 237
Angelica 202
  roseana 201
Anoda 173
  abutiloides 172
  acerifolia 172
  caudatifolia 172
  crenatiflora 172
    glabrata 172
  cristata 172
  hastata 172, 230
  incarnata 173
  parvifolia 172
  pentaschista 172
  punicea 173
Anona 215
  cherimolia 215
  glabra 215
  longiflora 215
  sp 228
Apple 214
Apricot 214
Arbutus sp 256
Arcocarpus fissuratus 258
Argithamnia sp 227
Arrayan 221, 225
Arrow, Indian 251
Aster latahensis 201
Attalea cohune 232, 237
Attole 218
Aspidium 146
  amplum 147
  conterminum 147
  macrophyllum 147
  martinicense 147
  molle 147
  parasiticum 147
  patulum 148
Asplenium ebeneum 148
    minor 148
  monanthum 148
  parvulum 148
  resiliens 148
  trichomanes 148
  trilobum 148
Avocado 215
  pear 215
Ayenia fruticosa 195
Azafran 227
Azal 259
Bamboo 241, 250, 252, 256
Banana 214
Banco del ide 244, 248
Barley 225, 230
  water 225
Bastardia *hirsutiflora* 178
Bastardiastrum 178
Bean 210, 212
Bejuco colorado 253, 255, 256
  de amole 235, 236
  de huico 231
Beschorneria 153
Bessera 256

Page.
Bessera fistulosa 256
Beverage plants 223
Beverages, distilled 223, 224
  fermented 223, 224
  nonintoxicating 224
Bidens palmeri 145
Bignoniaceae 258
Blackberry 214
  brandy 225
Bohadschia *humifusa* 166
Boliyo 244, 248
Bombax palmeri 179
Bravoa 151, 152, 153, 154
  densiflora 152, 155
  geminiflora 154, 237
  singuliflora 152
Brazil 237
  wood 251
  wood dye 240, 241
Bromelia 225
  pinguin 255
  spp 215, 255
  sylvestris 243
Brongniartia diffusa 194
  lunata 194
Broom, brooms 252, 253
  root 252, 253
Brush, brushes 239, 240, 242, 249, 252, 254
Brushes, fly 252
  hair 252, 253
Burro 244
Bursera microphylla 238
Byrsonima crassifolia 217, 257
Cabbage 226
Cables 242
Cacahuate 235
Cacahuianche 235
Cactaceae 220, 257
  superstitions respecting 258
Cactus 258
Caesalpinia coriaria 238
Calaleasilla 236
Calliandra 193
  emarginata 194
  laevis 194
  oaxacana 193
  penduliflora 193
  unijuga 193
Cana dulce 234, 235, 237
Capsicum annuum acuminatum 211
    cerasiforme 211
    grossum 211
    longum 211
  frutescens 211
  spp 210, 211
Carica papaya 214
Carum petroselinum 220
Cascalote bean 238
Casimiroa edulis 165, 217
Cassia pringlei 194, 195
  unijuga 195
  wislizeni 195
Castor oil 232
    bean 235
Cayaponia dubia 236
Cebollos 226

Page.
Cedrela 189
  angustifolia 190, 191
  fissilis 191
  imparipinnata 190
  mexicana 190, 191
  montana 189, 190
    mexicana 190
  oaxacensis 190, 191
  occidentalis 190
  odorata 190
Ceiba casearia 180, 250
  grandiflora 180, 250
  tomentosa 180
  spp 250
Celantillo de ojo de agua 228
Celastrus pringlei 195
Cereals 210
Cereus 220
  geometrizans 220
  giganteus 220
  marginatus 254
  pecten-aboriginum 221, 253, 254
  pitahaya 220
  tetazo 220
  thurberi 220, 254
  variabilis 220
  spp 220
Chaetocalyx *schottii* 158
  wislizeni 158
Cheilanthes *angustifolia* 149
  aurantiaca 148
  cuneata 149
  lendigera 148
  ochracea 148
Chenopodium incisum 228
Chia 225
  grande 225
Chicle, chicle gum 222
Chico 215
Chilacayote 223
Chile 211
  ancho 211
  cara 211
  colorado 226
  mirasol 211
  pequin 211
Chili sauce 211, 212
Chirimoya 215
Chocolate sticks 256
Cicer arietinum 213
Cinnamon bark 226
Ciruela 210, 217, 218, 219, 220
  amarilla 218, 219, 220
  campechana 220
  colorada 220
  red 218, 219
  roja 218, 220
  tree 218
  wild 219
  yellow 218, 219
Ciruelo 217, 225
Citrus medica 165
Claret 225
Cleome humilis 196
  tenuis 196
Clitoria glycinoides 169

Page.
Clitoria *grandiflora* 170
  humilis 169
  javitensis 169
  mariana 168, 169, 170
  mexicana 168, 169
  multiflora 169
  polystachya 169
  portobellensis 170
  schiedeana 170
  sericea 170
  speciosa 170
  subsessilis 169
  ternatea 168
  triflora 169
Cloth 242
Clothesline 255
Cocoanut 214
Cocojul 214
Cocurste 215
Cocurstle 215
Cogollo, cogollos 242, 243, 244, 248
Compositae 145
Coquito 232, 237
Coriander 226
Coriandrum sativum 226
Corn bread 210
  cakes 210
  indian 210
  meal 210
Corpus 228
Corrals 240
Cotton 251
  plant 251
  seed oil 232
  spinning 251
Couepia *kunthiana* 196
  polyandra 196, 216
Covillea tridentata 229
Crab apple 241
Crataegus 216, 241
Crescentia alata 258, 259
  fruit vessels 259
Crypsinna stricta 252
Crystalina 220
Cucurbita ficifolia 223
  foetidissima 236
Cudrado 213
Cuphea cristata 196
  graciliflora 196, 197
  koehneana 197
  llavea 145
  nudicostata 197
  pinetorum 197
  trichopetala 196
Cystopteris fragilis 148
Damiana 230
Dasylirion spp 224, 240
Date palm 214
Datura tatula 230
Decorative plants 256
Delphinoa 157
  gracillima 157
Dioscorea convolvulacea 236
  sp 236
Diospyros ebenaster 223
Dishcloth 249

Page.

- Doryanthes 153
- Dryopteris 146
  - ampla 147
  - contermina 147
  - martinicensis 147
  - patula 148
    - chaerophylloides 148
  - parasitica 147
- Dulce 218
- Dyo plants 237, 238
- Enchalada 226
- Entada polystachya 235, 236
- Enterolobium cyclocarpum 228, 235, 236, 238
- Epicampes macroura 252
  - sp 256
- Eriodendron *tomentosum* 180
- Erythrina flabelliformis 255
  - lanata 255
  - spp 255
- Eablichia odorata 165
- Espinocilla 230
- Estoca banco 244, 248
- Estropajos 251
- Euagave 224
- Euphorbia sp 229
- Euwaltheria 183
- Faba vulgaris 213
- *Fagara pterota* 164
- Fence plants 253–255
- Ferns 146
- Fiber plants 239–252
- Fierro tallador 244
- Fig 214
- Fire blower 241
- Firewood 255
- Fish poison 257
- Flavoring plants 226, 227
- Flor de venodillo 229
- Fly brush 240
- Fouquieria spinosa 255
- Frijol 212, 213
  - apasteado 212
  - blanco 212
    - nallado 213
  - cando 213
  - encrevado 213
  - garvanode picachos 213
  - guero 213
  - hortelano 212
  - lavareno 213
  - mesquitillo 213
  - mexicano 213
  - morado bola 213
  - negro 213
  - nuevo tempranillo 213
  - sequin 213
- Fruits 214–223
- Furcraea 153
- Garambullo 220
- Garvancillo verde 213
- Garvanzo de picachos 213
- Gobernadora 229
- Gordo 211
- Gossypium barbadense 180, 251
  - herbaceum 235
  - spp 235, 236

Page.

- Gourds 259
- Grasper 244, 248
- Grass, grasses 252
  - mountain 256
  - roots 252
- Gronovia longiflora 197
- Guaiacum coulteri 255
- Guapilla 243, 245
- Guava 221
- Guayaba 221
- Guayacan 255, 256
- Guazuma ulmifolia 256
- Haba 257
- Habilla 257
- Hachogue 236
- Haematoxylon boreale 237
  - campechianum 238
- Hand bags 242, 249
- Hats, palm-leaf 239, 240
- Hava 213, 257
- Hedge plants 254, 255
- Hedges, hedge fences 254, 255
- Hesperogenia 203
  - stricklandi 203
- Hibillo 257
- Hibiscus biseptus 174
  - coulteri 174
  - manihot 174
  - sabdariffa 225
  - rosasinensis *schizopetalus* 175
  - schizopetalus 175
  - sp 175
- Hieracium sp 231
- Higuerilla 235, 237
- Hikora 258
  - sunama 258
  - wanami 258
- Hinaeseli 230
- Hippocratea pauciflora 197
  - utilis 197
  - sp 253, 255, 256
- Hirtella *polyandra* 196
- Horsfordia newberryi 180
- Huamuchil 216
- Huila 224, 247, 249
- Huinecastle 228, 235, 236
- Hura crepitans 257
- Huts, material 240
- Hymenocallis sp 145
- Indian corn 210
- Ipazote del zorillo 228
  - skunk 228
- Iris sp 145
- Isote 241, 252
- Istle 244
- Ixtle 243, 244
  - fiber 244, 248
- Jabo 220
- Jamaica 225
- Jatropha curcas 229, 253, 255
  - platyphylla 254
  - spathulata occidentalis 238
- Javilla 257
- Karwinskia humboldtiana 229
- Kosteletzkya paniculata 180
- Ladles, wooden 256

Page.

- **Lagenaria sp** 259
- **L'aguapan** 257
- **Lantana sp** 230
- **Laurel** 226, 228
- **Lechuguilla** 231, 237, 241, 242, 243, 244
  - **plant** 248
- ***Leichtlinia*** 156
- **Lemons** 214
- **Lengua de cervo** 228
- **Leucaena sp** 229
- **Licania arborea** 234, 237
- **Lime juice** 225
- **Limes** 214, 224
- **Lippia** 226, 227
  - **berlandieri** 227
  - **palmeri spicata** 227
  - **purpurea** 227
- **Litsea glaucescens** 226, 228
- **Loeselia coccinea** 230
  - **sp** 230
- **Logwood** 238
- **Lophophora williamsii** 258
- **Luffa cylindrica** 251
- **Lysiloma candida** 238
- **Madroño wood** 256
- **Magnolia sp** 228
- **Maguey** 223, 233, 242
- **Majorana** 230
- **Malva *angustifolia*** 177
  - ***hederacea*** 176
  - **parviflora** 180
- **Malvaceae** 146
- **Malvastrum greenmanianum** 180
  - ***pedatifidum*** 177
  - **schaffneri** 180
  - **tricuspidatum** 181
- **Malvaviscus lanceolata** 175
  - **palmeri** 175
  - **pringlei** 175
- **Mamillaria** 258
  - **senilis** 258
- **Mamillopsis** 258
- **Manfreda, manfredas** 152, 153, 155, 242, 246
  - **spp** 145, 233
- **Mango** 214
- **Manzanilla** 230
- **Margarita** 229
- **Marrubio** 230
- **Marrubium vulgare** 230
- **Mat, mats** 237, 239, 241
- **Medicinal plants** 227-231
- **Meliaceae** 189
- **Melon zapote** 214
- **Melothria scabra** 181
- **Mescal** 224, 230
  - **flasks** 259
  - **maguey** 224
  - **plant** 210
- **Mesosphaerum suaveolens** 225
- **Metate** 210, 225
- **Midshipman's butter** 215
- **Minkelersia biflora** 145
- **Mint** 224
- **Monkey's dinner bell** 257
- **Moquilea *kunthiana*** 196
- **Mountain grass** 256

Page.

- **Muhlenbergia** 252
- **Mustard** 224
- **Myrtus arayan** 221, 225
- **Nanche** 217, 227
- **Neowashingtonia sonorae** 255
- **Nephrodium *molle*** 147
- **Nesaea longipes** 199
  - **pringlei** 198, 199
- ***Neurocarpum javitense*** 169
- **Nicotiana rustica** 258
- **Nissolia** 146, 157
  - ***confertiflora*** 157, 160
    - ***laxior*** 157, 162
  - **diversifolia** 160
  - **dodgei** 161, 163
  - **fruticosa** 157, 162, 163
  - **guatemalensis** 162
  - **hirsuta** 157, 160
  - **hirsutiflora** 163
  - **laxior** 162
  - **multiflora** 161
  - **nelsoni** 162
  - **platycalyx** 157, 159
  - **platycarpa** 157, 163
  - **pringlei** 158
  - **racemosa** 157, 163
  - **schottii** 157, 158, *160*, *163*
  - **setosa** 157
  - **wislizeni** 157, 158, *163*
- **Nolina** 240
- **Notholaena ferruginea** 148
  - **nivea** 148
    - **dealbata** 148
  - **schaffneri mexicana** 148
  - **sinuata** 149
- **Oak** 238, 250
- **Olive, olives** 217, 226, 227
  - **oil** 230, 232
- **Olla** 224
- **Onions** 226
- **Opuntia** 220
  - **ficus-indica** 220
  - **tuna** 220
  - **spp** 254
- **Oragano** 226
- **Orange** 214
- **Orchidaceae** 145
- **Oregano** 226, 227
- **Oregeno** 226
- **Organos** 254
- **Oxalis sp** 145
- **Palm** 239, 257
  - **leaves** 252, 253
    - **uses** 239, 240
  - **nut** 214, 232
  - **oil** 230, 232
- **Palma loca** 241, 243, 245
- **Palo blanco** 238
- **Pamita** 225
- **Papa** 227
- **Papaya** 214
- **Passiflora bryonoides** 182
  - **colimensis** 181
  - **foetida** 182
    - **arida** 182
    - **hastata** 182

Page.
Passiflora mexicana 182
  serratifolia 182
  sicyoides 182
  suberosa 183
Patol 213
Peach 214
Pear 214
Pellaea angustifolia 149
  cuneata 149
  cordata 149
  marginata 149
   pyramidalis 149
  seemanni 149
  ternifolia 149
Pepita 257
Pequin 211
Perijil 226
Periptera 173
  macrostelis 174
  periptera 173
  punicea 173
Persea gratissima 215, 257
Phaseolus lunatus 212
  spp 212
Phegopteris rudis 150
Physalis sp 210, 212
Physic nuts 220
Phytolacca icosandra 236
  octandra 236
Pineapple 214
Pinus 257
Piper palmeri 234, 236
Piqueria trinervia 231
Piriqueta 165
  cistoides 165, 167
Pitahaya 220, 221
  acre 221
  dulce 221
Pitaya 220
Pithecoctenium sp 231
Pithecolobium acatlense 195
  dulce 216, 217
  ligusticifolium 217
Plant worship 257
Polianthes 151, 152, 153
  tuberosa 154, 237
  sp 154
Polypodium angustifolium 150
  aureum 150
   areolatum 150
  elasticum 150
  fragile 148
  furfuraceum 150
  lanceolatum 150, 228
  molle 147
  parasiticum 147
  pectinatum 150
  skinneri 150
  subpetiolatum 150
  thysanolepis 150
  trilobatum 150
  stelliformis 145
Potato 226, 227
  sweet 227
  wild 227
Prochnyanthes 151, 152, 153, 155

Page.
Prochnyanthes viridescens 155, 234, 237
Prosopis 257
Pseudobravoa 153, 155
  densiflora 155
Psidium guava 221
  spp 221
Ptelea trifoliata mollis 165
Pteris aquilina lanuginosa 150
  aurantiaca 148
  cordata 149
  lutea 148
  rigida 149
  ternifolia 149
Pulque 223, 224
  agaves 255
  maguey 224, 245
  plant 210, 223
Puro cecillia 256
Quahtlatlatzin 257
Quercus 145
Rain coats 240
Raisins 226, 227
Raiz 252
Randia sp 256
Ranunculus alismaefolius 199
  madrensis 199
  vagans 199
Red peppers 210, 212, 226
Reel 250
Retranca 244, 248
Rice 217
  roots 252
Ricinus communis 235, 237
Robinsonella cordata 181
  discolor 181
  divergens 181
  lindeniana 181
Ropes 241, 242, 249, 250
Rosapara 258
Sabal 257
  spp 240, 252
Sablier 257
Sacks 242
Saddle sweaters 230
Salix sp 255
Salvia hispanica 225
  tiliaefolia 225
  spp 225
Samyda mexicana 199
Sandbox tree 257
Sangre grado 229, 253, 254
Sapindus galeottii 236
  inequalis 236
  marginatus 236
  saponaria 236
  sp 236
Sapota elongata 216
Savila 228
Scraper 244, 248
Seasoning plants 226, 227
Selinum 203
Semilla de Gicaura 213
Sesamum indicum 226, 235, 237
Shoe lasts 255
  pegs 256
Sida 253

Page.
Sida acuta carpinifolia ... 176, 253
  alamosana ... 175
  anomala ... 175
  carpinifolia ... 176
  caudatifolia ... 172
  cinerea ... 176
  cristata ... 172
  diffusa ... 176
  hederacea ... 176
  holwayi ... 176
  incana ... 170
  malvaviscus ... 173
  neo-mexicana ... 176
  periptera ... 173
  rubra ... 173
  salviæfolia ... 176
  spinosa ... 176
  stellata ... 177
  tragiaefolia ... 177
Sisal hemp ... 243
  hemp plant ... 239
Sisymbrium canescens ... 225
Skunk ipazote ... 228
Soap berry ... 232
  plants ... 231-237
Solanum tuberosum ... 227
Soliman ... 257
Sonorita ... 230
Sotol ... 224, 240, 241
  liquor ... 224
Soyate ... 240, 241
Spanish cedar ... 189
Sphaeralcea angustifolia cuspidata ... 177
  arida ... 177
  californica ... 177
  pedatifida ... 177
  stellata ... 177
Spindle ... 251
Spinner ... 249, 250, 251
Spondias lutea ... 218. 219, 220, 225
  mexicana ... 219
  purpurea ... 219, 220
  spp ... 217
Sponge, vegetable ... 251
Squash ... 226
Stegnosperma halimifolia ... 234, 236
Stegowaltheria ... 183
Stipa ... 252
Stock break ... 254
Story tree ... 222
String ... 242, 250
Suadadero ... 239
Superstitions respecting plants ... 227, 257. 258
Swietenia humilis ... 229
Tabaco de macuchi ... 258
Tabardillo ... 231
Table utensils ... 256
Tagetes lucida ... 231, 256
Tallador ... 244. 248
Tamarinds ... 224
  tree ... 225
Tamarindus indica ... 225, 257
Tampico fiber ... 243
  hemp ... 210, 242, 244
Tanning plants ... 237, 238
Tapemete ... 242, 246, 250

Page.
Tecomate ... 258
Tecote prieto ... 238
Tehuino ... 225
Tejocote ... 216, 241
Tepahuajo ... 229
Tequila ... 224
  bastard ... 249
Terminalia catappa ... 221
Tetereta ... 257
Thalictrum ... 185
  cuernavacanum ... 186. 187
  grandiflorum ... 188
  grandifolium ... 188
  guatemalense ... 188
  ichangense ... 186
  jaliscanum ... 186, 187
  lanatum ... 189
  madrense ... 188
  pachucense ... 188
  papillosum ... 189
  peltatum ... 185, 186. 187, 188
  pinnatum ... 188
  pringlei ... 185, 186, 187, 188
    reticulatum ... 188
  pubigerum ... 187
Thatching ... 256
Thread ... 242, 249, 250, 251
Tobacco ... 230, 258
Toloachi ... 230
Tomale ... 217, 221. 226, 237
Tomato ... 210, 212
Torote ... 238
Tortilla ... 210. 211, 226
Tradescantia ... 204
  brevifolia ... 207
  gigantea ... 205
  humilis ... 204
  leiandra ... 207, 208
    brevifolia ... 207
    ovata ... 207
  pilosa ... 208
  scopulorum ... 205
  speciosa ... 207
  tumida ... 208
  virginiana ... 204, 205, 208
    flexuosa ... 208
    tumida ... 208
  sp ... 145
Tree cotton ... 250
Treleasea ... 207
Treleasea brevifolia ... 207
  leiandra ... 208
  tumida ... 145, 208
Trompa ... 251
Tuna ... 209, 210, 220
Turnera ... 230
  alba ... 166
  aphrodisiaca ... 166, 167
  caerulea ... 166, 167
  callosa ... 165 167, 168
  cistoides ... 167
  diffusa ... 167
    aphrodisiaca ... 166, 167
  hindsiana ... 167
  humifusa ... 166. 167, 168. 230
  mollis ... 167

Page.

- Turnera palmeri 165, 167, 168
  - panamensis 167
  - pringlei 166, 167, 168
  - pumilea 167, 168
  - *trioniflora* 167
  - ulmifolia 166, 167, 168
    - acuta 167, 168
    - alba 166, 167, 168
    - caerulea 166, 167, 168
    - elegans 167
    - surinamensis 166, 167, 168
    - *velutina* 166, 167
  - velutina 167
  - sp 167
- Twine 249
- Umbelliferae 145
- Uvalama 223
- Vegetable butter 215
  - marrow 215
  - tallow 234
- Vegetables 210-213
- Velaea glauca 203
- Verbesina pinnatifida 255
- Vinegar 223
- Vines 256
- Vino tecomate 259
- Vitellaria mammosa 222
- Vitex mollis 223
- Walama 223
- Waltheria 146
  - acapulcensis 184
  - acuminata 183
  - americana 184
  - bracteosa 183
  - brevipes 184
  - detonsa 183, 184
  - glomerata 185
  - hirsuta 183, 184
  - indica 183
  - operculata 183
  - preslii 184
  - rhombifolia 185
  - *rotundifolia* 184
- Wash rag 249, 250
- *Washingtonia sonorae* 255
- Wax bean 213
- Whisk 252
- Willow 214, 255
- Wissadula acuminata 178
  - cincta 178
  - hirsutiflora 178

Page.

- Wissadula holosericea 178
  - paniculata 178
  - pringlei 178
  - scabra 177, 178
  - tricarpellata 179
  - trilobata 178
  - wissaduloides 179
- Wooden utensils 256
- Woods, useful 255, 256
- Woodsia mexicana 150, 151
  - mollis 151
- Woodwardia radicans 151
- Yerba de coyote 229
  - de golondrina 229
  - de torro 231
  - del cancer 229
  - nil 231
- Ystle 245
- Yucca 232, 239, 241, 243, 244
  - angustifolia 237
  - baccata 232, 237
  - filifera 241
  - leaves 252
  - rupicola rigida 237
  - treculeana 241
  - wood 248
- Zanthoxylum affine 165
  - arborescens 164
  - foetidum 164
  - ghiesbreghtii 164
  - insulare 163, 165
  - limoncello 164
  - longipes 163, 164
  - melanosticta 164
  - nelsoni 164, 165
  - occidentale 164
  - pentanome 164
  - pringlei 165
  - pterota 164
  - rigidum 165
- Zapote amarillo 216
  - blanco 217
  - chico 222
  - prieto 223
- Zea mays 210
- Zebrina *leiandra* 207
- Zephyranthes carinata 237
- Zephyranthes sp 145
- Zinnia linearis 231, 256
- Zizyphus 232
  - mexicana 235, 236

CONTENTS.

	Page.
Introduction	5
Climate	6
Temperature	6
Sunshine	8
Atmospheric humidity	8
Precipitation	9
Wind	10
Physiography	10
Geology and soils	11
The plant formations, their composition and physiognomy	13
Sand-strand vegetation	14
Treeless, open formations	14
Beach formation	14
Dune formation	14
Evergreen tree and shrub formations	15
Tree formation	15
Thicket formation	16
Salt-marsh vegetation	16
Creek-marsh formation	16
Spartina stricta association	16
Juncus roemerianus association	17
Dune-marsh formation	18
Tidal flat formation	18
Pasture and ruderal plants	19
Cultivated plants	19
Ecological forms and adaptations to environment	19
Adaptations to the mechanical action of the wind and the instability of the soil	20
Adaptations for protecting the supply of water	21
Anatomy	24
Species of the sand strand	29
Panicum amarum	29
Muhlenbergia filipes	29
Spartina patens	32
Spartina stricta	33
Chloris petraea	34
Uniola paniculata	36
Yucca aloifolia	37
Yucca gloriosa	37
Myrica carolinensis	38
Myrica cerifera	38
Quercus virginiana	38
Zanthoxylum clava-herculis	39
Croton maritimus	40

Anatomy—Continued. Page.

Species of the sand strand—Continued.

Ilex vomitoria ... 40
Oenothera humifusa ... 41
Teucrium nashii ... 41
Physalis viscosa ... 42
Salt-marsh species ... 45
Triglochin striata ... 45
Spartina stricta ... 45
Juncus roemerianus ... 45
Sesuvium maritimum ... 46
Tissa marina ... 46
Kosteletzkya virginica ... 47
Ammania koehnei ... 47
Vincetoxicum palustre ... 47
Lippia nodiflora ... 48
Monniera monniera ... 49
Solidago sempervirens ... 49
Aster tenuifolius ... 50
Aster subulatus ... 50
Baccharis halimifolia ... 51
Iva frutescens ... 52
Borrichia frutescens ... 53
Geographical affinities of the flora ... 56
List of plants collected and observed ... 58
Bibliography ... 63

ILLUSTRATIONS.

Fig. 1. *Muhlenbergia filipes*—transverse section of leaf ... 30
2. *Muhlenbergia filipes*—ventral epidermis of leaf ... 30
3. *Muhlenbergia filipes*—dorsal part of leaf blade ... 30
4. *Muhlenbergia filipes*—portion of mestome bundle ... 31
5. *Chloris petraea*—leaf blade ... 34
6. *Chloris petraea*—ventral portion of leaf blade ... 35
7. *Chloris petraea*—large mestome bundle from leaf blade ... 35
8. *Chloris petraea*—three small mestome bundles from the blade ... 36
9. *Yucca aloifolia*—leaf surface ... 37
10. *Yucca aloifolia*—a stoma ... 37
11. *Quercus virginiana*—stellate hair from dorsal leaf surface ... 39
12. *Croton maritimus*—hair from dorsal leaf surface ... 40
13. *Physalis viscosa*—branched hair from leaf ... 42
14. *Tissa marina*—glandular hair from leaf margin ... 46
15. *Lippia nodiflora*—stomata and hairs ... 48
16. *Iva frutescens*—hair from ventral leaf surface ... 52
17. *Borrichia frutescens*—leaf section ... 53
18. *Borrichia frutescens*—leaf hairs ... 53

THE PLANT COVERING OF OCRACOKE ISLAND; A STUDY IN THE ECOLOGY OF THE NORTH CAROLINA STRAND VEGETATION.

INTRODUCTION.

In October, 1898, in the course of field work for the United States Department of Agriculture, the writer spent five days upon Ocracoke Island, North Carolina. Owing to its limited size, it was possible, even in that short time, to explore somewhat thoroughly a considerable part of the island. It is to be regretted that visits were not made to the locality earlier in the season, so that the phenological development of the vegetation could be studied. However, as most of the characteristic plants of our southern Atlantic strand are rather late in maturing, it is probable that a better season for a single visit could not have been chosen. It was of course impossible to make any valuable observations upon fecundation and dissemination, important as these subjects are to the study of the geographical distribution of plants. What is said here of Ocracoke will doubtless apply, in a general way, to the other sandy reefs of the North Carolina coast.

The object of this paper is a study of the ecology and geography of the vegetation of the island, the several divisions of the subject being presented in the following order:

(1) Climate; (2) physiography; (3) geology and soils; (4) the plant formations, their composition and physiognomy; (5) ecological forms—adaptations to environment; (6) anatomy; (7) phytogeographical affinities of the flora.

The nomenclature used is mainly that followed in Britton and Brown's Illustrated Flora of the Northern United States and Canada, but, in order that those who are interested in ecological work and are not familiar with this nomenclature may find no difficulty in recognizing the species described, the names used in the later works of Gray and of Chapman are quoted in parentheses. A full list of all plants collected or observed upon the island is appended, and here, again, familiar synonyms are cited in parentheses. A list of the works quoted, with their full titles, is given at the end of the paper.

In the preparation of the anatomical portion of the paper, Mr.

Theodor Holm has rendered valuable assistance, and he has kindly furnished the drawings for figures Nos. 1 to 8, 17, and 18. The other figures were drawn from nature by the author.

CLIMATE.

The following data have been obligingly furnished by the United States Weather Bureau. The observations were made at the Hatteras Station, only a few miles northeast of Ocracoke.

TEMPERATURE.

Readings were taken in the shade.[1] The observations at Hatteras cover a period of about twenty years. The average number of days per annum with a temperature exceeding 6° C. (43° F.) is 365, while at Norfolk, Va., the number is only 295. The sum total of temperatures above 6° C. during the year averages 3,749.4° C. (6,749° F.), which is notably higher than the Norfolk figure of 3,359.4° C. (6,047.0° F.). The normal mean temperature during the six consecutive hottest weeks of summer is 25.9° C. (78.6° F.), as compared with the slightly higher mean of 26.3° C. (79.3° F.) at Norfolk.

The normal annual temperature is 16.3° C. (61.4 F.), as compared with 14.8° C. (58.7° F.) at Cape Henry, Virginia, 15.0° C. (59.0° F.) at Norfolk, Va., and 17.2° C. (63.0° F.) at Wilmington, N. C.

The normal monthly temperatures are as follows:

	Degrees C.	Degrees F.		Degrees C.	Degrees F.
January	7.6	45.7	July	25.5	77.9
February	8.1	46.6	August	25.2	77.4
March	10.0	50.1	September	23.2	73.7
April	14.0	57.2	October	18.0	61.5
May	19.1	66.4	November	13.1	55.6
June	23.3	74.0	December	9.0	48.2

The normal daily range of temperature for the whole year amounts to 6.3° C. (11.3° F.), as compared with 8.2° C. (14.7° F.) at Cape Henry, 8.8° C. (15.8° F.) at Norfolk, and 9.6° C. (17.3° F.) at Wilmington.

The normal daily ranges for each month are as follows:

	Degrees C.	Degrees F.		Degrees C.	Degrees F.
January	7.0	12.7	July	5.5	10.0
February	7.1	12.8	August	5.1	9.2
March	7.2	12.9	September	5.3	9.6
April	6.9	12.5	October	5.7	10.2
May	6.4	11.5	November	6.3	11.3
June	5.7	10.3	December	7.1	12.8

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[1] Consequently they do not represent the temperature to which most of the vegetation is actually exposed, being subject to insolation during the hours of sunshine. They are chiefly valuable for purposes of comparison with other climates.

The absolute maximum temperature observed was 38.8° C. (102° F.), as compared with 39.4° C. (103° F.) at Cape Henry, 38.8° C. (102° F.) at Norfolk, and 39.4° C. (103° F.) at Wilmington.

The absolute minimum temperature observed was —13.3° C. (8.0° F.), as compared with — 15.0° C. (5.0° F.) at Cape Henry, — 16.6° C. (2.0° F.) at Norfolk, and — 12.8° C. (9.0° F.) at Wilmington.

The absolute monthly maxima and minima are as follows:

Month.	Maximum.		Minimum.	
	Degrees C.	Degrees F.	Degrees C.	Degrees F.
January	26.1	79	—10.0	14
February	22.8	73	—11.7	11
March	29.4	85	— 3.3	26
April	30.0	86	— 0.6	31
May	33.9	93	6.1	43
June	38.8	102	12.8	55
July	37.2	99	16.1	61
August	36.1	97	13.6	62
September	35.0	95	10.0	50
October	32.2	90	5.5	42
November	26.1	79	— 2.2	28
December	22.8	73	—13.3	8

The average date of the latest killing frost in spring is February 25, as compared with March 19 at Cape Henry, March 26 at Norfolk, and March 15 at Wilmington. The latest recorded was April 5, as compared with April 19 at Cape Henry, April 26 at Norfolk, and April 20 at Wilmington.

The average date of earliest killing frost in autumn is December 13, as compared with November 14 at Norfolk and Cape Henry and November 12 at Wilmington. The earliest killing frost recorded was on November 12, as compared with November 14 at Cape Henry, October 15 at Norfolk, and October 13 at Wilmington.

From the above data the temperature may be characterized as follows: Warm, but not excessive, with a considerable sum total of effective temperatures during the growing season, and usually mild temperatures during the very brief dormant period. The normal temperature is at least 6.5° C. above freezing point during every month of the year. The normal amount of daily variation of temperature is, according to the season, from 5° to 7° C., a relatively very small range. The period between the average dates of the earliest killing frost in autumn and of the latest in spring, which may be taken as very roughly coinciding with the dormant period of most of the vegetation, covers only seventy-four days.

SUNSHINE.

The observations cover a period of nearly thirty years. Normal annual sunshine,[1] stated in percentages of possible sunshine, 54, as compared with 52 at Cape Henry, 51 at Norfolk, and 52 at Wilmington. The monthly percentages are as follows:

Month.	Per cent.	Month.	Per cent.	Month.	Per cent.
January	46	May	59	September	56
February	47	June	55	October	58
March	52	July	55	November	54
April	55	August	52	December	53

Normal annual sunshine, stated in hours, 2,392.2, as compared with 2,314.6 at Cape Henry, 2,270.1 at Norfolk, and 2,312.7 at Wilmington. The normal monthly number of hours of sunshine are:

Month.	Hours.	Month.	Hours.	Month.	Hours.
January	144.7	May	256.2	September	208.3
February	143.7	June	238.9	October	203.0
March	193.4	July	243.1	November	167.4
April	216.0	August	216.9	December	160.6

These records yield the result that the normal annual percentage of sunshine is low compared with that in much of the territory of the United States, especially west of the Mississippi River; but it is not much less than that prevailing in other parts of the Southeastern States, while it exceeds the percentages given for the northern portion of the Atlantic slope.

ATMOSPHERIC HUMIDITY.

This is stated in percentages of possible saturation, which of course varies at different seasons with the temperature, etc. Annual (for a period of seven years), 81.4 as compared with 74 at Cape Henry, and 73 (during nine years) at Norfolk and Wilmington. Monthly, as follows:

Month.	Per cent.	Month.	Per cent.	Month.	Per cent.
January	84	May	82	September	81
February	81	June	83	October	81
March	79	July	83	November	79
April	80	August	82	December	82

The annual percentage thus shown is greater than that recorded for any other station in the United States, excepting those in the

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[1] These figures only approximate the real values. They are derived from statistics of cloudiness.

Puget Sound region, and even there the excess over the Hatteras figure is not great. Moreover, this humidity is distributed throughout the months of the year with remarkable uniformity, the variation between any two months amounting to not more than 5 per cent.

PRECIPITATION.

This is stated in centimeters and inches. Annual, 159.4 centimeters (66.41 inches), as compared with 125.6 centimeters (52.34 inches) at Cape Henry, 125.0 centimeters (52.1 inches) at Norfolk, and 130.4 centimeters (54.34 inches) at Wilmington. Monthly, as follows:

Month.	Centimeters.	Inches.	Month.	Centimeters.	Inches.	Month.	Centimeters.	Inches.
January	14.2	5.91	May	11.0	4.60	September	15.4	6.44
February	10.7	4.47	June	10.9	4.57	October	14.8	6.17
March	14.6	6.10	July	15.4	6.43	November	12.4	5.18
April	11.3	4.72	August	15.2	6.35	December	13.1	5.47

The average annual number of rainy days is 123.8, as compared with 125 at Cape Henry, 131.3 at Norfolk, and 128.8 at Wilmington. The average monthly number of rainy days is as follows:

Month.	Days.	Month.	Days.	Month.	Days.
January	15.9	May	10.0	September	13.7
February	10.2	June	9.6	October	7.5
March	11.9	July	10.2	November	6.7
April	8.4	August	10.2	December	9.5

At Hatteras the precipitation consists almost entirely of rain. Rain-bearing storms usually approach from a westerly direction. Winter and spring rains are usually of light intensity and long duration, while those of the summer and fall are more often brief and torrential in character.

The results viewed comparatively are as follows: The normal annual rainfall is remarkably heavy, exceeding that at the nearest station, Wilmington, by 30 centimeters. Only on the coast of Washington and Oregon does the total rainfall within the limits of the United States notably exceed that of Hatteras. The normal variation between the month of least and that of greatest rainfall does not exceed 5 centimeters, so that in ordinary seasons periods of drought do not occur. The heaviest rainfall occurs in the months from July to October. The average number of rainy days is large, about one-third of the days of the year, and is distributed with relatively great uniformity, varying from 6.7 days in the month of least to 15.9 in the month of greatest number of rainy days.

Of dewfall no statistics could be obtained.

WIND.

The average annual maximum velocity of the wind is 21.4 kilometers (13.3 miles) per hour, as compared with 23.2 kilometers at Cape Henry, 15.1 at Norfolk, and 15.4 at Wilmington. The average monthly maximum velocities, stated in kilometers and miles, are as follows:

Month.	Kilometers.	Miles	Month.	Kilometers.	Miles	Month.	Kilometers.	Miles
January	25.0	15.5	May	20.3	12.6	September	17.2	10.7
February	24.5	15.2	June	21.3	13.2	October	18.4	11.4
March	25.2	15.6	July	18.5	11.5	November	19.8	12.3
April	24.2	15.0	August	19.7	12.2	December	24.0	14.9

In regard to direction, the winds of midwinter are usually from the north, while those of midsummer are usually from a little west of south.

As thus shown, the average velocity of the wind is considerable, and the amount of its variation from month to month is remarkably slight. The highest average of course prevails in winter and early spring. In midwinter, when the winds are normally strongest and therefore most affect the perennial, especially the woody vegetation, their prevailing direction is almost due south (from the north), hence, in the case of Ocracoke, from the mainland.

In regard to temperature, rainfall, and atmospheric humidity the climate of Ocracoke and Hatteras is suitable for a vigorous forest growth. But the exposure to strong winds, and the peculiar soil conditions, neutralize these favorable factors and give it a typical strand vegetation, which much resembles that of deserts. In the neighborhood of Norfolk and of Wilmington, where conditions of temperature and of humidity are really somewhat less suitable than at Hatteras to the most luxuriant development of plants, the virgin growth is almost everywhere dense forest, because there the inimical conditions are absent.

PHYSIOGRAPHY.

Ocracoke Island is part of that long chain of narrow sand reefs which fringes the southern Atlantic Coast of the United States, and which forms the eastern barrier to a series of almost land-locked bays and sounds. Ocracoke lies in longitude 76° west and latitude 35° 10′ north, and is therefore somewhat south of the center of the North Carolina coast. It is separated from Hatteras Reef by the 0.8 kilometer (one-half mile) wide strait known as Hatteras Inlet, and from Portsmouth, the next island below, by Ocracoke Inlet, 3 kilometers (nearly 2 miles) wide. Ocracoke itself is about 26 kilometers (16 miles) in length, and extends from that great bulge of the coast line known as Cape Hatteras, in a southwesterly direction. The island's greatest width near its lower end falls short of 3 kilometers; the average width is only 1 kilometer, while in places it is even narrower. Outside rolls the Atlantic, while between island and mainland stretch the waters of Pamlicò Sound, here from 30 to 45 kilometers (18 to 27 miles) wide. Pamlico differs from the shallower Albemarle Sound to the north in the important respect that its water is always salt, while Albemarle is normally fresh.

Near the southwestern extremity of the island a broad expanse of tidal flat separates the higher land of the village of Ocracoke from the Atlantic beach. One and one-half kilometers or so toward the northeast this lagoon disappears, and dry land extends from the flat sandy beach and the salt marshes which border the Sound to the dunes which front the ocean. Into these marshes penetrate tiny creeks, whose ramifications cut the lower part of the island in all directions. Almost the whole area is divided between sand strand and tidal marsh. Much of it is only 1 meter or less above normal high tide and subject to overflow when strong easterly gales are blowing, or when stiff breezes from the opposite quarter mass the waters of Pamlico Sound against the western shore of the island. The highest land on Ocracoke is represented by sand dunes often 3, sometimes 8 meters high. These are usually regular in form and fairly well fixed by the vegetation. Those that abut upon the outer beach or rise amid the mud flats are particularly regular and dome-shaped.

GEOLOGY AND SOILS.

Of the geology of Ocracoke and its neighbor Hatteras, we have comparatively little knowledge. Shaler[1] has advanced the theory that these reefs were built up from the detritus which resulted from the glacial excavation of Delaware and Chesapeake bays. Kerr[2] describes Hatteras as a "sort of delta." "The action," he says, "of the tides and ocean currents, the Gulf stream and Arctic current meeting at this point, accumulates upon Hatteras the river silt which reaches the sea by way of the Chesapeake as well as that of the rivers which discharge their burdens through the inlets about this point and southward. * * * Hatteras is not a modern phenomenon. It is at least as old as the Cretaceous; the Quaternary as well as the Tertiary of this coast region of North Carolina are laid down upon an eroded surface of Cretaceous rock." From measurements elsewhere made, the probable depth beneath the surface of the Cretaceous formation on Hatteras and Ocracoke would be somewhere between 200 and 300 meters. I am not aware that borings of any considerable depth have been made upon these islands.[1] Kerr further states that "the reef is increasing in continuity and breadth." But this is not the general opinion, for it is said that there is to-day water of considerable depth where houses stood upon Ocracoke within the memory of living men, and it is stated[2] that "a fine fig orchard and many peach trees, with a fine potato patch and garden," occupied earlier what is now Hatteras Inlet. That the present tendency of this whole coast line is one of subsidence can hardly be disputed.

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[1] Proc. Bost. Soc. Nat. Hist., vol. 14, pp. 110 to 121. 1872.

[2] Bul. Wash. Phil. Soc., vol. 6, pp. 28 to 30. 1884.

Beneath the superficial Recent deposits of dune sands and salt-marsh silt which cover the greater part of the island lie the sands and clays of the Columbia formation, which extend to a considerable but unascertained depth. This and the Recent accumulations are the only geological formations of this part of the coastal plain which need be considered in relation to the existing plant covering.

Excepting the areas occupied by creeks and salt marsh, the soil of Ocracoke is a fine white marine sand, almost everywhere devoid of any considerable admixture of humus. Only in the live-oak groves is there enough vegetable matter present to give the sand a gray color. There is doubtless some quantity of calcium carbonate in the soil, owing to the presence of small particles of shells washed up by the waves and scattered by the wind.[3]

As much of the island is subject to occasional inundation and to the deposition of spray by the winds, the soil content of sodium chlorid must be considerably greater at times than in ordinary inland soils.[4] There is no lack of moisture in this sandy substratum. Even in the driest looking beach sand, water usually stands at a depth of only 15 to 30 centimeters (6 to 12 inches) from the surface. The superficial layer of the sand acquires a great amount of heat on sunny days and becomes thoroughly desiccated, in which condition it is subject to being blown about by the wind, its degree of coherency depending upon the character of the vegetation. At night, however, sand gives up its heat rapidly and absorbs much dew, if conditions are favorable.[5]

The soil of the salt marsh, which appears to be usually a thin sheet of fine, brown silt overlying a stiff, bluish clay, contains organic matter in considerable quantity and is therefore capable of supporting a denser plant growth than is found upon the sands. It is of course saturated with salt or brackish water.

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[1] The succession of strata in the North Carolina coastal plain, where exposed in the valleys of the Neuse and Cape Fear rivers, is given as follows, beginning with the oldest:

(1) Potomac gravel, sands, and clays.
(2) Cretaceous sands and clays.
(3) Tertiary (Eocene and Miocene) marls and clays.
(4) Lafayette (yellowish and brownish sands and loams).
(5) Columbia sands, gravels, and clays.

[2] W. L. Welch. Bul. Essex Inst., vol. 17, pp. 37 to 42. 1886.

[3] According to Contejean (Géogr. Bot.), the proportion of calcium carbonate thus supplied to the strand soils is insignificant except near the wave limit, the particles being soon dissolved by the carbon dioxide contained in rain water and then washed down through the readily permeable soil.

[4] Sea water contains from 2.7 to 3.2 per cent of $NaCl$.

[5] Warming, Lehrbuch, p. 66.

There is no outcrop of any kind of rock on the island.

THE PLANT FORMATIONS, THEIR COMPOSITION AND PHYSIOGNOMY.

The various assemblages of species and individuals which make up the plant covering of Ocracoke Island may be classified as follows:[1]

I. Sand-strand vegetation.
  1. Treeless (open).
    (*a*) Beach formation: Croton-Physalis association.
    (*b*) Dune formation:[2] Uniola-Yucca association.
  2. Evergreen trees and shrubs.
    (*a*) Tree formation: Quercus virginiana association.
    (*b*) Thicket formation: Ilex vomitoria association.
II. Salt-marsh vegetation.
  1. Creek-marsh (closed) formation.
    (*a*) Spartina stricta association.
    (*b*) Juncus roemerianus association.
  2. Dune-marsh formation: Lippia-Monniera association.
  3. Tidal flat (open) formation: Sesuvium-Tissa association.
III. Pastures and ruderal plants.
IV. Cultivated plants.

It is not to be supposed that the several groups are always or even commonly sharply defined. On the contrary the transition from one to another is almost always gradual, so that portions of the plant covering are difficult to classify. Nevertheless, the formations and associations are distinct features of the landscape, easily recognizable by any observer.

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[1] It has seemed best to use the word "formation" in the same sense as employed by the German and most other plant geographers—i. e., to designate the larger assemblages. For more restricted groups, whether composed of one or many species, the term "association" is to be preferred. The nearly equivalent German word "Verein" is used as a translation of the Danish "Samfund" in one of the most important works on the subject (Warming, Lehrbuch) for the larger assemblages or formations; but, in the want of a better English word it has been thought expedient to employ "association" for the more restricted assemblages, which are peculiar to each biogeographical area. While the formations are purely ecological elements which recur in the strand vegetation of other regions, being for the most part closely dependent upon topographical features, the associations are often quite local; and owe much of their character to the particular groups of species which compose them.

[2] It is not possible to distinguish here several dune formations, such as occur, for example, on the coast of Virginia.

SAND-STRAND VEGETATION.

TREELESS, OPEN FORMATIONS.

BEACH FORMATION.

This formation occurs along Pamlico Sound, occupying the flat or gently sloping sandy beach, especially toward the lower end of the island. The species are almost all herbaceous and usually form an open vegetation, leaving much of the soil uncovered. The most abundant is *Croton maritimus*, which sometimes grows rather closely, excluding other species. By reason of its silvery-gray color, due to a close, stellate, scale-like pubescence, it is one of the most conspicuous plants of the island. It is usually stout and often much-branched. Another noteworthy plant is *Physalis viscosa*, a perennial herb, with slender roots, sometimes 1.5 meters long, creeping near the surface of the sand, and sending up at intervals short leafy shoots. Its color varies from green to gray with the density of its covering of branched hairs. An interesting feature of this formation is the occurrence in places of diminutive thickets only 1 to 3 decimeters high, composed chiefly of *Ilex vomitoria* (*I. cassine* of authors), *Zanthoxylon clavaherculis*, *Juniperus virginiana*, with leaves only of the spreading form, and *Opuntia pes-corvi*, with its long spines. Among other species belonging to the beach formation, there are of annual herbs *Euphorbia polygonifolia*, *Triplasis purpurea*, a canescent form of *Solanum nigrum*, a large-fruited *Xanthium*, and *Salsola kali*, the last being the most abundant; of perennial herbs *Teucrium nashii*, with slender stolons and white-tomentous lower leaf surface, *Chloris petraea*, with decumbent culms, rooting at the nodes, *Panicum neuranthum*, and occasionally *Capriola dactylon* (*Cynodon dactylon* Pers.); of woody plants *Rubus trivialis* and *Smilax bona-nox* occur here and there, with prickly stems trailing over the sand.

DUNE FORMATION.

Open dunes are occupied chiefly by the handsome sea oats, *Uniola paniculata*, the most characteristic strand plant of the Southeastern States. The low, rounded dunes which rise from a bare pebbly shingle on the ocean side of the island, and here and there in the midst of the tidal flats, support no other vegetation. The leafy shoots of this grass are produced in great abundance, but flowering branches are much less numerous.[1] *Muhlenbergia filipes* is abundant on and among the dunes, its delicate purplish panicles, swaying with the lightest breath of air, presenting a most beautiful appearance. It is almost the only cespitose plant of the island, and grows in tufts that are sometimes 3 decimeters in diameter. Rather small plants of *Yucca gloriosa*, with fleshy rootstocks often exposed by the shifting of the sands, are frequent on the lesser dunes. The single specimen of *Yucca aloifolia* observed was over 2 meters high, with stem branched several times above the ground. Both species have exceedingly hard and sharp spinous leaf tips. On some of the higher dunes depauperate plants of the shrubby *Myrica carolinensis*, mostly only 3 to 6 decimeters high, associate with the Uniola. Of secondary importance in this association are two perennial grasses, *Panicum amarum minus* and *Spartina patens* (*juncea*); as well as a probably biennial thistle, *Carduus spinosissimus* (*Cnicus horridulus*); and several other herbs, among them the white-sericeous *Oenothera humifusa* and *Croton maritimus*.

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[1] In this respect the Uniola resembles *Ammophila arenaria*, which takes its place farther north.

EVERGREEN TREE AND SHRUB FORMATIONS.

TREE FORMATION.

Scattered over the island, but preferring the higher dunes which occupy its inner side, are small groves of live oak, *Quercus virginiana* (*Q. virens*), either in pure association or mixed with some other trees. The oaks are usually 6 to 9 meters high and 3 (rarely 7½) decimeters in diameter. Those on the northern edges of the groves have trunks strongly inclined toward the south, and, as a consequence of the denudation of the branches on the windward side, the whole crown of foliage lies to leeward of the axis. One could not desire a better indication of the prevailing direction of strong winds in the region.[1] The branches, gnarled and twisted, are clad with numerous lichens, chiefly *Usnea barbata*, and with occasional small wisps of Spanish moss (*Tillandsia usneoides*), which evidently maintains but a precarious foothold on the trees of this wind-exposed island.

Altogether the aspect of the groves is rather weird and somber. Often associated with the oaks are small trees of *Myrica cerifera*, *Zanthoxylum clava-herculis* and *Ilex vomitoria*, all of about the same maximum size (6 meters high and 2 decimeters in diameter), and occasionally *Juniperus virginiana*, which rarely attains a height of 9 meters and a diameter of 3 decimeters. Lianas are sparingly represented by *Smilax bona-nox*, *Vitis aestivalis*, and *Rhus radicans*, all three species sometimes attaining considerable size and climbing to the tree tops. The last is, however, usually of the creeping form, with the main stem underground. The herbaceous members of this association are, in the smaller groves, chiefly plants characteristic of the open strand, *Chloris*

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[1] All the specimens of live oak seen were apparently of considerable age. Seedlings were few or none, and no acorns were observed. It is probable that instead of increasing, the oak is here holding its ground with difficulty. So highly are the trees valued as wind-breaks by the inhabitants that none are felled, all fuel being brought from the mainland. The rounded shrubby form of this plant, common elsewhere on the coast, was not observed on Ocracoke.

petraea, *Physalis viscosa*, *Diodia teres*, etc., and the difference in soil and light is not sufficiently great to cause any apparent modification in the plants. In larger groves, where the light is more diffused and some humus collects, *Oplismenus setarius*[1] covers the ground with its creeping stems, associated with such normally shade-loving species as *Sanicula* sp., *Asplenium platyneuron* (*A. ebenoides*), *Uniola laxa* (*U. gracilis*), *Panicum laxiflorum* and two mosses, growing on the ground, *Bryum argenteum* and *Rhynchostegium serrulatum*.

THICKET FORMATION.

Thickets of *Ilex vomitoria*, by far the most abundant woody plant of Ocracoke Island, often cover the low dunes, especially near the inner side of the island. The plants are here usually 10 to 20 decimeters high, with short, rigid, thorn-like branches, light-gray bark, thick evergreen leaves and bright scarlet berries. The branches are often shaggy with lichens, notably *Ramalina montagnei*. Occasionally the Ilex gives place to small, dense thickets of *Myrica carolinensis*, sometimes 4½ meters high. This formation corresponds in a measure to the "Maquis" or "Garrigues" of the western Mediterranean region.[2] The herbaceous species that have established themselves among these shrubs are chiefly such as are most abundant on the beach and open dunes. Two thin-leaved, shade-loving herbs are occasional, *Parietaria debilis* with weak, much-branched stems, and *Melothria pendula*, with twining stems.

SALT-MARSH VEGETATION.

CREEK-MARSH FORMATION.

Salt marshes fringe all the small creeks and ditches that intersect the lower part of the island, and sometimes cover broader tracts immediately bordering the sound with a growth that is almost everywhere dense and reed-like. Two rather sharply defined belts are distinguishable along the larger creeks, an outer, covered chiefly with *Spartina stricta*, and an inner, where *Juncus roemerianus* predominates. The latter alone occupies the small creeks and ditches which are farthest from the beach.

SPARTINA STRICTA ASSOCIATION.

The Spartina prefers the edge of open water, where it is in large part submerged at high tide. It has a light, yellow-green color during the growing season, but is brown and discolored much of the year. The stems are usually about 6 decimeters high. *Salicornia herbacea*, often bright red and conspicuous, grows rather abundantly with the grass.[1] *Distichlis spicata* (*D. maritima*) usually accompanies this association, but is not of primary importance.

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[1] In southern Mississippi, also, I found this species growing only in the shade of *Quercus virginiana*.

[2] Compare Grisebach, Veg. der Erde, vol. 1, pp. 294, 328, etc.

JUNCUS ROEMERIANUS ASSOCIATION.

The Juncus roemerianus association occupies much more ground than that of Spartina, and comprises a much larger number of species. It is best developed on land that is merely wet a great part of the time, and covered with, at most, only a few centimeters of water at high tide. The Juncus is of a dark-green color, and usually reaches a height of about 1 meter, making a dense growth of stiff, sharp-pointed stems and leaves. Among the secondary members of this association certain grass-like plants occur locally in some quantity. Notable are *Chaetochloa imberbis perennis*, with weak, slender culms from short, knotted rootstocks, preferring the borders of the marsh, and *Typha latifolia*, usually standing in water of some depth. *Spartina patens* (*S. juncea*) is occasional, the salt-marsh form being smaller and more slender than that which grows upon the sand strand. *Paspalum distichum* and *Distichlis spicata* are also met with in more open places among the Juncus.

Compositae, with mostly rather succulent leaves, are conspicuous, especially near the margin of this association. *Aster tenuifolius*, a slender rush-like perennial species whose few branches terminate in solitary, rather large heads with showy white rays, is less abundant than the related *Aster subulatus*, a much-branched, often rather stout annual with numerous inconspicuous heads. *Solidago sempervirens* and *Baccharis halimifolia* are most at home on the edge of the Juncus growth. Both are showy plants, the latter with bright white pappus, the former with a golden-yellow panicle. *Borrichia frutescens*, one of the most characteristic plants of the strand, prefers comparatively open spots where the ground is merely wet. It has a stout stem, usually 3 to 6 decimeters high, thick whitish leaves, and yellow sunflower-like heads. *Iva frutescens* is the most abundant composite of the marshes, almost always associating with the Juncus. Two climbing plants, *Galactia volubilis* (*G. pilosa*) and *Vincetoxicum palustre*, a glabrous, narrow-leaved asclepiad, occur near the edges of the marsh, twining around the stems of the rushes and other plants. *Atriplex hastata* is occasional in similar situations. Even *Ilex vomitoria* sometimes strays into the marsh, growing among the Juncus as a low straggling shrub.

Somewhat different is the assemblage of species about the small pools that frequently interrupt the growth of *Juncus roemerianus*.

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[1] Likewise in southwestern France, *Spartina stricta* and *Salicornia herbacea* form the outermost association in soil that is submerged at high tide. (Contejean, Géogr. Bot., p. 56.) According to Warming (Lehrbuch, p. 307) *Salicornia herbacea* grows unmixed with other species as the outermost embryophytic vegetation on the eastern shores of the North Sea. *Spartina stricta* does not range so far north in Europe.

Their borders are the favorite habitat of a characteristic malvaceous plant, *Kosteletzkya virginica*, which has rather thin, pubescent leaves and large rose-colored flowers. With it grow a species of Rumex, *Ipomoea sagittata*, *Solidago sempervirens*, *Cladium effusum* (a stout sedge with sharply saw-edged leaves), *Panicum walteri*, and, very conspicuous where it occurs, *Andropogon glomeratus* (*A. macrourus*). In the shallow water of these pools grows *Monniera monniera* (*Herpestis monniera* H. B. K.) in its aquatic, partially submerged form with elongated stems, as well as *Ammannia koehnei*, *Pluchea camphorata*, and a species of Eleocharis.

DUNE-MARSH FORMATION.

A low, rather scanty vegetation covers limited areas of wet sand which fringe the reed marsh, separating it from the dry strand, and also occurs here and there in depressions among the dunes. The most characteristic species are the terrestrial form of *Monniera monniera* with short internodes, and *Lippia nodiflora*, both having repent stems rooting at frequent intervals and leaves usually appressed to the ground. In the case of Lippia, however, the leaves are sometimes nearly vertical in strong sunlight, giving the plant a peculiar appearance. Each of these species sometimes occupies small tracts to the exclusion of other vegetation. They usually grow together, however, and in association with *Hydrocotyle umbellata*, *Centella asiatica*, and *Diodia virginiana*, all small plants with creeping or prostrate stems. Among the dunes Lippia and Herpestis sometimes play a less important part, and an assemblage of species, some of which are not normally halophilous, covers the ground. Of these *Juncus dichotomus*, *J. scirpoides*, *Scirpus americanus* (*S. pungens*), *Triglochin striata*, and *Mikania scandens* are more at home in saline soils, while *Ludwigia microcarpa*, *L. alata*, *Cynoctonum mitreola* (*Mitreola petiolata*), and *Dichromena colorata* (*D. leucocephala*) are character plants of the fresh-water marshes of the region. Such commingling is perhaps to be explained by the fact that these hollows among the dunes derive their moisture largely from the rainfall, while, on the other hand, spray-laden winds contribute a certain amount of salt to the soil.

TIDAL FLAT FORMATION.

This is an open formation, occupying the margins of the shallow lagoon at the lower end of the island, which is under water at flood tide. The soil is a mixture of silt and sand. A sparse growth of *Sesuvium maritimum* (*S. pentandrum*), *Tissa marina* (*Lepigonum salinum*), and *Scirpus americanus* forms a characteristic association. *Paspalum distichum*, with prostrate culms, sometimes 2 meters long, rooting at the nodes, as well as scattered erect tufts of *Fimbristylis spadicea*, were the only other species observed in this formation.

PASTURE AND RUDERAL PLANTS.

A considerable area towards the lower end of Ocracoke, especially in and near the village, is covered with a fine turf composed almost entirely of *Capriola dactylon*, closely grazed by horses, cattle, and sheep. Here and there over these pastures are scattered groups of various weeds, notably *Cassia occidentalis*, *Sporobolus indicus*, and *Solanum carolinense*, as well as a species of *Xanthium*, *Bidens bipinnata*, *Chenopodium anthelminticum*, *Ambrosia artimisiaefolia*, *Verbascum thapsus*, etc., all of which have undoubtedly been imported into the island by the agency of man. Occasionally, strays from the indigenous formations are met with here. Fleshy fungi are sparingly represented.

CULTIVATED PLANTS.

As far as was ascertained, the only plants now cultivated upon the island are fig trees (*Ficus carica*), which are planted about dwellings and freely mature their fruit in this mild climate. Small paper mulberry trees (*Broussonetia papyrifera*) are established in door yards. According to a statement above quoted, peach trees and potatoes were formerly grown. Attempts to cultivate garden vegetables are usually terminated by inroads of the sea during a gale, which leave the soil strongly impregnated with salt.

ECOLOGICAL FORMS AND ADAPTATIONS TO ENVIRONMENT.

In considering the physical environment of plants upon Ocracoke Island, and the various modifications of the vegetative organs whereby they are adapted to their medium, it is evident that many of the latter fall readily into two categories: (1) Adaptations protecting against the mechanical action of the wind[1] and the unstable nature of the soil; and (2) modifications that assist the plant to increase or conserve its supply of water. Sand-strand and salt-marsh species alike require both sorts of modifications, although the latter formation is less exposed to wind and the shifting of its substratum. However, not only the vegetation upon loose sand, but that which covers the muddy bottom of the salt marshes, must accommodate itself to a more or less incoherent and mobile soil. To the first category are to be referred most of the noteworthy life forms of the island, i. e., those in which the epharmonic peculiarities of structure (such as are due to the direct action of the physical environment) extend to the entire organism. To the second belong chiefly modifications of a particular organ, the leaf.

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[1] The exposed position of the island, and its consequent relative poverty in large woody growth, renders herbaceous vegetation here more than usually subject to the action of the wind.

ADAPTATIONS TO THE MECHANICAL ACTION OF THE WIND AND THE INSTABILITY OF THE SOIL.

A notable characteristic of the vegetation is the prevalence of low forms. Tall stems (more than 1 meter high) among herbaceous species which are not grass-like, are almost wanting. Often the stems creep above or below the surface of the ground and root at intervals.

Lippia nodiflora, *Monniera monniera*, *Capriola dactylon*, and *Paspalum distichum* have stems creeping upon the surface. These may be regarded as humble representatives of the Pes-caprae form, which is so characteristic of tropical strands.[1] Species possessing creeping subterranean stems, from which arise subaerial leafy and flowering branches, are *Panicum amarum minus* and *Uniola paniculata*, as well as many of the salt-marsh plants, notably *Juncus roemerianus*, *Typha latifolia*, and *Spartina stricta*, whose strong, creeping rhizomes form a dense sod in the loose mud. In *Uniola paniculata* the rootstock is stout and descends obliquely or almost vertically deep into the sand. *Physalis viscosa* has a long, slender, branching root, which creeps horizontally often a distance of a meter or more near the surface, and originates at intervals erect, leafy and flowering branches. *Teucrium nashii* possesses thickish stolons, which arise in the axils of the scale-like, lowest leaves.

Other species growing on the sands have prostrate stem branches, which do not root after leaving the main axis. These may be long and trailing, as in the woody *Rubus trivialis*, or short and radiating in all directions from the primary axis as in certain annuals, *Diodia teres*, *D. virginiana*, *Mollugo verticillata*, and *Euphorbia polygonifolia*, as well as the biennial *Oenothera humifusa*. This radiant form,[2] as we may term it, is not so abundant and characteristic here as at other points along the Atlantic coast of the United States.

The cespitose form is apparently not well adapted to conditions upon Ocracoke, for it is well developed only in *Muhlenbergia filipes*.

The shrubs and trees of the island show the effect of much exposure to high wind in their short gnarled branches and in the often one-sided position of their crown of foliage, the last peculiarity being especially noticeable in the live oak. Here, however, we have to do rather with the direct mechanical effect of the wind than with a protective modification.

As further adaptations against the coast winds, whose destructiveness to tender vegetation must be greatly increased by the quantity of sand they carry, should be cited the great development of mechanical tissue in the leaves of many species—e. g., *Uniola paniculata*, *Juncus roemerianus*, *Quercus virginiana*—and the strong thickening of the outer cell walls of the epidermis, to which is due the hard polished surface exhibited by the larger grass-like plants and by the evergreen leaves of *Quercus* and *Ilex*. This last peculiarity is, however, doubtless primarily induced by the necessity for protection against loss of water.

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[1] Schimper, Indo-Mal. Strand-flora, p. 78.

[2] Schimper (Strand-flora, p. 81) describes this form as occurring in the East Indian strand vegetation.

ADAPTATIONS FOR PROTECTING THE SUPPLY OF WATER.

Strand plants upon Ocracoke Island, unlike desert plants, are not to any noteworthy extent equipped with special apparatus for collecting or for storing water, if we except the development of water-storage tissue in several of the salt-marsh species. The obvious reason is the absence of a period of drought, there being at all times a relatively high percentage of water in the air and the soil. On the other hand, both maritime and desert vegetations are characterized by certain peculiarities of structure, especially of the leaves, which are usually denominated xerophytic, albeit these are less strikingly developed in strand plants than in those which inhabit deserts. Such common points of resemblance are, as is well known, due to a common necessity for protection against excessive loss of water by transpiration from the leaves, and this despite the abundant supply of water in the environment of strand plants.

In the case of salt-marsh vegetation it is chiefly the presence of a comparatively high percentage of sodium chlorid in the soil water which necessitates a xerophytic structure. Just how this salt reacts upon the life processes of plants and what the precise mode is by which plants protect themselves against its injurious effects are much mooted questions.[1]

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[1] Contejean (Géogr. bot., pp. 71, 94) holds that salt is harmful to most plants; that it is not indispensable even to strand plants, and that the latter are confined to an otherwise unfavorable habitat merely by their inability to compete in the struggle for existence with the salt-shunning species of nonsaline soils. That this view is only partially correct is suggested by the known tendency of halophilous (salt-loving) species to take up greater quantities of sodium chlorid, even when grown in nonsaline soils, than do plants which are not halophilous.

Schimper (Strand-flora, pp. 25, 26) attributes to the accumulation of sodium chlorid in the green tissue an injurious effect upon assimilation, particularly upon the production of starch and sugar. More recently (Pflanzengeogr., p. 100) he modifies this view, but still emphasizes the importance of a chemical action of the salt upon metabolism, the synthesis of proteids being the process chiefly affected.

In order to reduce this deleterious action to a minimum, the accumulation of sodium chlorid in the tissues must be as far as possible retarded. This is accomplished, according to Schimper's theory, by diminishing root osmosis and hence the volume of the ascending column of water holding the chlorid in solution, this end being secured by means of certain modifications of leaf structure that reduce the volume of transpired water. Besides this chemical effect, Schimper also admits a direct physical influence which the presence of common salt in the soil exerts upon the process of osmosis. As Sachs (Landw. Versuchsst. vol. 1, p. 223) demonstrated by experiment, the roots of ordinary plants take up with difficulty water which holds in solution sodium chlorid (as well as other salts, notably calcium sulphate), a difficulty that of course increases with the concentration

Factors in the physical environment of sand-strand vegetation which tend to accelerate transpiration from the surface of the plant, and hence contribute to the necessity for xerophytic structure, are:

1. Exposure without shelter to the almost continual and often violent movement of air currents, which keep the plant's atmospheric envelope constantly changing and prevent it from approaching a condition of saturation.

2. Intense light, both direct and reflected from the surface of the sand. Light, which becomes converted into heat in the chlorophyll tissue, increases transpiration[1] in proportion to its intensity. Besides this effect of light, its direct and harmful action, when too intense, upon the chlorophyll is to be guarded against, and this is probably effected by some of the modifications which also serve to reduce transpiration. But in the present state of our knowledge it is impossible to discriminate between the respective modifications which protect the plant against these two effects of light.

3. Great heat during a great part of the year. Much more intense than the atmospheric heat is that which is absorbed by and reflected from the superficial layer of sand.[2]

It is probable, however, that the presence of a high percentage of sodium chlorid in the substratum is at least as effective as any of these causes in bringing about xerophytic structure. This is evident

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of the solution. Whether this is equally true of halophilous species is not established.

L. Diels (Jahrb. Wiss. Bot. vol. 23, p. 316) doubts that osmosis in plants of saline soils is sufficiently reduced to account for the absence of accumulations of salt to an injurious extent in the tissues. He found that salt-marsh plants when transferred to distilled water showed a steady loss of salt from day to day, although the impossibility of an excretion of the sodium chlorid as such could be demonstrated. This author gives a number of analyses of halophilous species which would indicate that in plants of that character the cells are enabled to decompose the accumulated sodium chlorid, the sodium probably uniting with malic acid, while the chlorin possibly combines with water and passes off through the roots as hydrochloric acid. It is known that xerophytic modifications which protect the plant against excessive transpiration at the same time cause an increased evolution of free acids (notably malic acid) in the green tissue, by preventing the ready access of oxygen and otherwise hindering the exchange of gases between the plant and the atmosphere. These researches of Diels, if confirmed for halophilous plants generally, will prove an insuperable objection to Schimper's theory that such plants can prevent an indefinite accumulation of sodium chlorid in their tissues only by reducing root action and hence transpiration. If we accept Diels's conclusions, we should have to refer the xerophytic structure of halophilous plants largely to its efficacy in preventing a free exchange of gases between plant and atmosphere, thus rendering imperfect the combustion of carbohydrates in the plant tissues and occasioning the production of considerable quantities of organic acids, which serve the plant by decomposing the absorbed sodium chlorid.

[1] Wiesner. Untersuch., p. 506.

[2] Volkens (Fl. Ægypt., p. 14) found a difference of from 22° to 24° C. between the temperatures of the surface soil and of the atmosphere in the shade near Cairo, in Egypt, the maximum heat of the sand being 55° C.

when we examine the salt-marsh vegetation. Most of the species of that formation, even those which are wholly or partially submerged at high tide, possess such structure. No plants of the North Carolina strand are more conspicuously xerophytic in structure than *Salicornia herbacea* and *Spartina stricta*. That such structure is closely related to the ability to take up NaCl in considerable quantities is proved by the fact that certain species which do not naturally inhabit saline soils, but which possess strongly developed modifications against excessive transpiration, can absorb that salt in quantities that are fatal to plants not so constituted.[1]

For this reason species belonging respectively to the sand strand and to the salt marsh of Ocracoke Island are not distinguished in the following enumeration of the means by which transpiration is reduced.

1. Reduction of the transpiring surface.

(*a*) Leaves small: *Ilex vomitoria* (smallest-leaved of our species of Ilex), *Galactia volubilis* (unusually narrow-leaved form), *Vincetoxicum palustre*, *Tissa marina* (leaves hemicylindrical), *Monniera monniera*, *Lippia nodiflora* (leaves notably smaller than in nonsaline soils), *Sesuvium maritimum*, etc. Most of the species enumerated have small or narrow leaves as compared with the nearest related inland forms.

(*b*) Leaves scale-like, their functions transferred to the stem, which is succulent; stem succulents: *Opuntia pes-corvi*, *Salicornia herbacea*.

(*c*) Leaves conduplicate or involute, especially in dry, sunny weather, so that only the dorsal surface is exposed: All the grasses, and *Cladium effusum*, *Fimbristylis spadicea*, and other sedges. In the grasses this characteristic is correlated with the position of the stomata, which lie at the bottom of furrows, especially on the unexposed ventral surface, and are further protected from air currents by a network of hairs which line the walls. In *Quercus virginiana* the leaf margins frequently become more or less revolute.

(*d*) Leaves perfectly terete and in structure little differentiated from the stem: *Juncus roemerianus*.

2. Position of the transpiring surface, leaves vertical or nearly so: Many of the grasses and sedges, *Typha*, *Juncus roemerianus*, *Triglochin striata*, young leaves of *Yucca* spp., *Lippia nodiflora* (sometimes), *Vincetoxicum palustre* (leaves reflexed), the Compositae.

3. Development of protective modifications in the epidermis.

(*a*) Thickened cuticle: Many species, notably the larger grass-like plants and woody species with evergreen leaves. A shining upper leaf surface, as in *Ilex vomitoria*, may be of use by reflecting some of the incident light rays, as has been suggested by Wiesner.

(*b*) Waxy covering: *Panicum amarum*, *Uniola paniculata*, *Euphorbia polygonifolia*, etc. This character is but slightly developed in the vegetation of Ocracoke Island.

(*c*) Hairy covering: *Oenothera humifusa* and *Teucrium nashii* (hairs long, simple); *Quercus virginiana* (stellate hairs on the dorsal surface only); *Kosteletzkya virginica* and *Croton maritimus* (hairs stellate, scale-like); *Physalis viscosa* (hairs forked); *Borrichia frutescens* (young leaves very densely covered with short hairs, giving the surface a glistening appearance). Interesting hairs also occur on other species, but not in sufficient numbers to serve as a protective covering (except in the leaf furrows of certain Gramineae).

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[1] Schimper, Pflanzengeogr., p. 99.

4. Succulency.

(*a*) Stem succulents: *Opuntia pes-corvi*, *Salicornia herbacea*.

(*b*) Leaf succulents: *Yucca* spp., *Tissa marina*, *Sesuvium maritimum*, *Euphorbia polygonifolia*, *Vincetoxicum palustre*, *Aster subulatus*, *A. flexuosus*, *Solidago sempervirens*—mostly salt-marsh species. Not only does the increase in thickness of the leaf serve directly as a protection against excessive loss of water, but the thickening tissue consists, in most cases, of colorless, water-storage parenchyma, which is peculiarly tenacious of its water supply.

5. Structure of the chlorenchyma.

Nearly all the species, of both sand strand and salt marsh, are characterized by the development of palisade, a compact chlorophyll tissue with cells more or less elongated at a right angle to the surface and occupying the exposed face or faces—i. e., the ventral face in bifacial leaves, both faces in such as are isolateral. Such tissue is believed to have, among other functions, that of protecting against excessive loss of water the remainder of the leaf (the interior. or the lower face, as the case may be), which is usually occupied by less compact tissue.

6. Aromatic, volatile oil.

An oil of this character is secreted by the species of Myrica. It has been suggested, although the idea needs substantiation, that the possession of such oils affords protection against excessive loss of water by the formation about the plant of an envelope, which is less pervious to heat rays than is ordinary air. At any rate this is a frequent attribute of plants inhabiting very dry regions.[1]

Not to be interpreted as affording protection against excessive transpiration, yet perhaps largely due to the influence of conditions that necessitate such protection, is the development of short, rigid, almost thornlike branches (*Ilex vomitoria*) and of prickles and spines (Smilax, *Rubus trivialis*, Opuntia, Zanthoxylum, leaf apices of the species of Yucca). Probably the depauperate form assumed by some of the woody species when growing on the beach is similarly explicable.[2]

Strong thickening of the under-ground parts for storage of reserve food materials does not occur in many species. The only notable cases detected were *Smilax bona-nox* (rootstocks with tuberous thickenings), *Yucca* spp. (rootstocks large, fleshy), and *Kosteletzkya virginica* (root stout, woody, vertical).

ANATOMY.

In almost all cases the histological structure of the leaf alone is here considered, that being the organ which shows most plainly adaptations to certain factors of the environment, notably those which affect transpiration. The general peculiarities of leaf anatomy in the vegetation of the sand strand and of the salt marsh, respectively, are first enumerated, and the resemblances and differences of plants of the two formation classes are pointed out. Several of the more important species of each category, in all thirty-two, are then taken up and described in systematic order. Tables showing what are believed to be the characters that are most important from an ecological point of view have been prepared for the two groups of species. For a number of species the material studied was not obtained upon Ocracoke Island, but from similar situations on the coast of Virginia, and in all such cases the source of the specimens used is mentioned. In some cases comparisons are made with related species, usually from other formations, in order to make clear the differential characters of the strand species.

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[1] Haberlandt, Pflanzenanat., p. 325. Volkens, Fl. Ægypt., p. 46.

[2] A like depressed habit is characteristic of shrubs growing above the limit of trees in high latitudes and altitudes. It is usually attributed to exposure to strong, dry winds, which is probably the chief factor in its development on the beach of Ocracoke Island.

In a great majority of the sand strand plants the leaf is bifacial, the two species of Yucca being the only exceptions noted. In some species this specialization is imperfect, as in *Oenothera humifusa.* In other cases the differentiation of the two sides of the leaf is complete, as in *Quercus virginiana.* In most cases the leaf is thick as compared with the same organ in related nonmaritime species. Good examples are the evergreen, leathery leaves of *Quercus virginiana* and *Ilex vomitoria,* as well as the leaves of the two grasses, *Uniola paniculata* and *Panicum amarum.* A strongly thickened cuticle is an almost invariable character, and this is conspicuously wrinkled in a few species. The lateral walls of the epidermis cells are undulate in four species, viz, the comparatively thin-leaved *Chloris petraea, Teucrium nashii,* and *Physalis viscosa,* and the thick-leaved *Ilex vomitoria.*

Half of the species have stomata on both leaf surfaces, but in every such case they are especially protected—in the grasses by being situated in furrows; in the species of Yucca by being deeply sunken, and in Physalis, Oenothera, and Croton by a covering of hairs. In the woody species they are always on the dorsal or lower surface only, and in *Quercus virginiana* they are further protected by a hairy covering (as also in the herbaceous *Teucrium nashii*).

Hairs form a dense, protective covering on both leaf surfaces of Oenothera, Croton, and Physalis, which species have stomata on both surfaces: only on the dorsal surface in Quercus and Teucrium, agreeing with the position of the stomata on that surface only. In Quercus and Croton the hairs are pluricellular and stellate; in Physalis they are irregularly branched; in Oenothera and Teucrium they are elongated, unbranched, and unicellular. Teucrium also possesses short, glandular, capitate hairs.

The chlorophyll tissue is homogeneous in the monocotyledons of the sand strand, while in the dicotyledons it is more or less differentiated into palisade on the ventral side of the leaf and pneumatic tissue on the dorsal side. The palisade is mostly quite compact, but never of more than 3 and usually of only 1 or 2 layers.

Colorless parenchyma, which probably performs the function of water-storage tissue, occurs in considerable quantity only in the grasses and the species of Yucca.

Stereome occurs subepidermally (especially in the leaf margins) in the Gramineae only. In most of the species of the sand strand, however, it is found as a support to the mestome bundles. These are furthermore reinforced by hypodermal collenchyma or collenchymatic tissue in most of the dicotyledonous species, this tissue probably serving as a protection against loss of water by evaporation from the vessels.

The sand-strand grasses deserve further mention with reference to their leaf structure. It belongs to a type of which *Chloris petraea* exhibits one extreme and *Muhlenbergia filipes* the other—the type exhibited by most grasses of deserts and steppes. The salt marsh *Spartina stricta* exhibits a wholly similar arrangement of tissues.

The margins are more or less conduplicate or involute when the supply of water is small, becoming flat when moisture is plentiful, except in the leaf of *Muhlenbergia filipes*, which is conduplicate, without power to unfold, and appears as if terete. The result of this adaptation is that in dry, sunny weather only the dorsal leaf surface is directly exposed to the air and light. In *Panicum amarum* and *Chloris petraea* the movement is effected by true bulliform cells, while in the other grasses (except, of course, Muhlenbergia) the function is probably performed by certain large but otherwise undifferentiated cells of the epidermis, which may be regarded as undeveloped bulliform cells.

The stomata lie near the bottom of deep longitudinal furrows and usually occur more abundantly on the protected ventral surface of the leaf, but in *Chloris petraea* only on the dorsal surface. The walls of these furrows, in Muhlenbergia, Uniola, and *Spartina patens*, are lined with unicellular, simple, prickle-like hairs, which doubtless hinder the escape of moist air.

Subepidermal groups of stereome occur in the leaves of all the grasses and in the margins of all except the Muhlenbergia. In this great development of strengthening tissue we have in all probability a protection against the mechanical effects of the wind, to which strand grasses are much exposed.

The chlorophyll tissue is in every case radially arranged in single layers around or at each side of each mestome bundle. In most cases the adjacent cells of the parenchyma sheath also contain chlorophyll.

Each mestome bundle is surrounded by a mestome sheath in all the species except *Uniola* and *Muhlenbergia*, and this by a large-celled parenchyma sheath. The parenchyma sheath without the mestome sheath occurs in *Muhlenbergia*.

Among the species of the salt marsh which were examined, the isolateral type of leaf prevails, *Kosteletzkya virginica* and *Lippia nodiflora* being the only exceptions, and in these the leaves are but imperfectly bifacial. In *Juncus roemerianus* the leaf is terete. Thick leaves are also the rule in this formation class, although less strikingly so than in the sand strand, because of the lack of large woody plants; and the thickened leaf is usually of a soft, succulent character rather than leathery. A majority of the species show a conspicuously thickened cuticle, which is strongly wrinkled in 7 out of 15 of them and granular or warty in 3 more.

Corresponding to the isolateral structure of most of the leaves we find stomata on both surfaces in 12 species; on the whole circumference of the terete leaf of *Juncus roemerianus;* confined to the ventral or upper surface only in *Spartina stricta* and *Borrichia frutescens.* In 4 species the guard cells are slightly prominent, in 7 level with the epidermis, in 3 slightly sunken, in 1 (*Spartina stricta*) situated near the bottom of deep furrows. Hairs occur in but 5 species. In Borrichia alone they form a dense covering, nearly every epidermal cell appearing to have developed a pluricellular, thin-walled hair by tangential division. It is evident that we have in this case an admirable protection against excessive transpiration.

Stereome occurs in notable quantity only in the leaves of *Spartina stricta* and *Juncus roemerianus.* In both it is subepidermal as well as about the mestome bundles. *Juncus roemerianus* is especially noteworthy for the strong development of both peripheral and axial stereome groups. Hypodermal collenchyma, or collenchyma-like tissue, occurs opposite the veins in two-thirds of the species examined.

The chlorenchyma is homogeneous in all but 2 species, and in 1 of these, *Lippia nodiflora,* the differentiation is slight. In nearly all the species it consists of compact palisade, interrupted in several cases by ducts or lacunes. In the leaves of most of the species there are only 2 layers on each side of the isolateral leaf, but in *Juncus roemerianus* the bands of well-developed palisade are 5 or 6 layers thick. In several of the Compositae, all decidedly halophilous species, the ends of the palisade layers where they abut upon the midvein converge toward the vein and appear as if radiating from it. This was observed in *Iva frutescens, Baccharis halimifolia,* and *Aster tenuifolius,* and may occur in other species. The significance of this arrangement is not known. It is cited by Warming[1] as a halophytic character. *Spartina stricta* agrees in the arrangement of its chlorophyll tissue, as in other respects, with the sand-strand grasses.

Colorless parenchyma, which probably serves for the storage of water, is present in greater or less quantity in 8 species, occupying the greater part of the interior of the leaf in 4, while occurring only about the veins in the others. In Borrichia, which is one of the most xerophytic in structure of all the salt-marsh species, this tissue is best developed. It is also well exemplified in *Tissa marina.*

In the 3 salt-marsh inhabiting monocotyledons examined—*Triglochin striata, Spartina stricta, and Juncus roemerianus*—each mestome bundle is provided with a well-marked mestome sheath and, outside that, a parenchyma sheath.

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[1] Halofyt-Studier, p. 250.

When we compare the species belonging to the two formation classes, sand-strand and salt-marsh, we find that a majority of both have several characters in common, all of which are distinctly xerophytic and are usually interpreted as protecting the leaf against excessive transpiration as well as the effects of too intense light. These are: Thickened leaves, thickened cuticle, and development of the chlorophyll tissue as compact palisade on the most exposed surface or surfaces.

More numerous, however, are the differential characters. The leaves of the sand-strand species are usually bifacial, with stomata only on the dorsal surface or, if on both surfaces, protected by a hairy covering or lying in deep furrows; and the palisade is situated on the more exposed upper or ventral side of the leaf. The salt-marsh species, on the other hand, have mostly isolateral leaves, vertical or nearly vertical in position, with stomata and palisade on both surfaces, and (with one exception) lacking the dense hairy covering. Conformably, the most common grass of the salt marsh, *Spartina stricta*, otherwise so similar in leaf structure to the dune form of *S. patens*, has no hairs lining its stomatal furrows. The cuticle is wrinkled or warty in many more salt-marsh than sand-strand species. Water-storage parenchyma, which is notably developed in the sand-strand vegetation only in the monocotyledons, is present in a majority of the salt-marsh plants of the most diverse relationship.

Corresponding to their growth in usually open formation, and consequently greater exposure to the wind, the sand-strand plants show a much stronger development of stereome than do the salt-marsh species. On the other hand, the latter are better provided with hypodermal collenchyma, or collenchymatic tissue, opposite the veins; but this may be more important as a protection against loss of water than as a mechanical strengthening tissue.

It should be emphasized that not only the peculiarities common to plants of the two formation classes, but likewise most of their respective differential characters, are really of a xerophytic nature.[1] In some cases, however, a different means has been employed by sand-strand species on the one hand and by salt-marsh species on the other to secure the same end—protection against excessive transpiration and the harmful action of too intense light.

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[1] In his most recent paper on the subject, Warming (Halofyt-Studier, p. 235) writes: "It is not possible, from the investigations here described, to draw any clear distinction between characters which are truly xerophytic and such as are truly halophytic, if any really exist." Schimper (Pflanzengeogr., p. 99) also holds that halophytes can not be distinguished as a class from xerophytes, since the principal object of the peculiarities of structure observable in plants growing in saline soil, however moist, is the reduction of transpiration, just as it is in plants surrounded by a physically very dry soil and atmosphere.

SPECIES OF THE SAND STRAND.

PANICUM AMARUM Ell.[1]

Leaf bifacial, strongly involute when dry, midrib not prominent on the dorsal surface and not much so on the ventral surface, shallow furrows (deepest each side of the midrib), with broad and rounded intervening ridges on the ventral surface, corresponding to very slight depressions on the dorsal surface.

Epidermis: Ventral, similar to the dorsal, but with thinner outer cell walls; stomata at each side of the group of 3 thick-walled bulliform cells at the bottom of each furrow; hairs none. Dorsal with very thick, porous outer cell walls, 1 or sometimes 2 short cells alternating with long ones, except in the rows containing stomata; stomata lying in the shallow furrows, with walls of the guard cells much thickened; hairs none.

Subepidermal stereome in large groups above and below the midrib, that above separated from the hadrome by several layers of thickish-walled, colorless parenchyma; smaller groups above and below the other nerves; strongly developed in the margins.

Chlorophyll tissue (palisade) arranged radially in a single layer about each mestome bundle, almost completely encircling the smaller nerves, interrupted above and below the larger ones, each 2 neighboring rows of palisade separated by a single layer of colorless parenchyma; chlorophyll likewise occurring in the cells of the parenchyma sheath which adjoin the palisade.

Mestome bundles surrounded each by a mestome sheath which, in the larger veins, has all, or nearly all, of its cells with walls (especially the inner) strongly thickened; mestome sheath in turn surrounded by a large-celled parenchyma sheath; mestome parenchyma in a single layer of thick-walled cells separating the hadrome from the leptome.

MUHLENBERGIA FILIPES M. A. Curtis.[2]

Leaf (fig. 1) conduplicate without power to unfold, appearing as if terete, slightly asymmetrical, margins almost meeting above the midnerve, and hence only the dorsal surface exposed. From the slight opening between the margins to the midrib extends a narrow fissure, with lateral furrows between the larger nerves reaching more than halfway to the dorsal surface of the leaf. The ridges above the mestome bundles between these furrows are broad and rounded at apex, except that of the midnerve, which is narrowed outward (hence conical in cross section). On the dorsal (outer) surface are narrow, slit-like furrows between each 2 nerves (hence 2 to every ventral furrow), opening into wider air spaces with stomata at each side of the bottom. Stomata also occur near the bottom of the ventral furrows, but are there less numerous.

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[1] The typical form of this species was not observed upon Ocracoke Island, but the leaf of var. *minus* Vasey & Scribner, which was collected there, corresponds in every detail to that of the type.

[2] Compare Volkens's figure and description of *Aristida ciliata* (Fl. Ægypt, pp. 49, 150, *t. 16, ff. 4 to 7*).

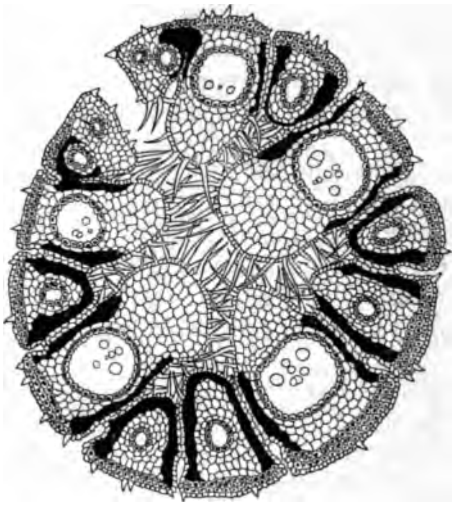

FIG. 1.—*Muhlenbergia filipes*—transverse section of leaf. Scale 75.

Epidermis: Ventral (fig. 2) with cell walls thinner than on the dorsal surface, many of the cells extended into straight or curved, spreading, unicellular hairs which line the main cavity and lateral furrows with a dense cross work, and are larger, thinner-walled, and more slender than those which occur on the dorsal surface; bulliform cells none. Dorsal (fig. 3) with smaller cells, the outer wall and cuticle so greatly thickened as nearly to equal the cell lumen, the areas lying above the subepidermal strands of stereome having single rows of short cells which alternate with several rows of long ones; many of the epidermal cells extended into short, stout, pointed, thick-walled, unicellular, appressed, prickle-like hairs, which line the furrows.

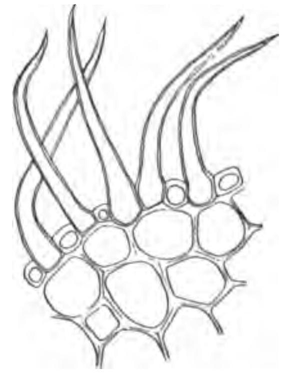

FIG. 2. *Muhlenbergia filipes* ventral epidermis of leaf. Transverse section, showing the hairs. Beneath the epidermis are layers of colorless parenchyma. Scale 400.

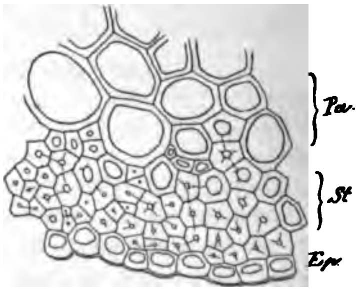

FIG. 3.- *Muhlenbergia filipes*—dorsal part of leaf blade. Transverse section showing the epidermis (Ep.), stereome (St.), and rather thick-walled colorless parenchyma (Pa.), which borders on the mestome bundle. Scale 400.

Subepidermal stereome: None on the ventral side of the leaf and in the margin; on the dorsal side in the form of flattened supporting strands[1] beneath the mestome bundles, passing gradually into the often thick-walled, colorless parenchyma which separates it from the mestome sheath.

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[1] "Abgeplattete Träger," Schwendener, Mechan. Princ., p. 40.

Chlorenchyma (fig. 4) consisting of small, branched cells with small intercellular spaces in a single layer radially arranged about each mestome bundle, lying only at the sides of the larger bundles, but extending in horseshoe form around the ventral (hadrome) portion of the smaller ones. Parenchyma sheath of the mestome bundles, where adjoining chlorenchyma, also containing chlorophyll.

Colorless parenchyma (fig. 4) occupying the larger ventral ridges (over the larger mestome bundles), and in 2 or 3 rows of cells between each 2 nerves, extending from the ventral to the dorsal furrows. Also in 1 or 2 rows separating the chlorenchyma from the parenchyma sheath of the smaller bundles.

Mestome bundles (fig. 4) with a large-celled parenchyma sheath; mestome sheath none, but mestome parenchyma with cell walls (especially the inner) much thickened, surrounding the larger nerves, simulating a mestome sheath; many of the companion cells in the leptome very thick-walled.[1]

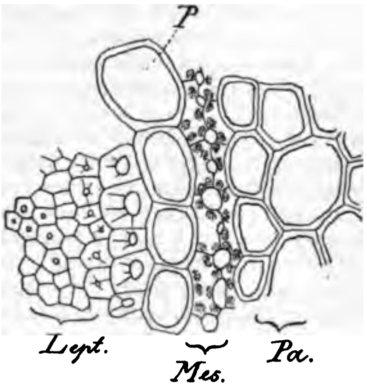

FIG. 4.—*Muhlenbergia filipes*—portion of mestome bundle. Transverse section of blade, showing a part of the leptome (Lept.), the parenchyma sheath (P), the chlorenchyma (Mes.), and the colorless parenchyma (Pa.) between the mestome bundles. Scale 600.

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[1] The two species of Muhlenbergia most nearly allied to *M. filipes* are *M. capillaris* (Michx.) Kunth and *M. trichopodes* (Ell.) Chapm. Chapman regards *M. filipes* as a variety of *M. capillaris*, but the striking histological differences, together with good morphological characters, show that in *M. filipes* we have a perfectly valid species.

A comparison of the leaf anatomy of the three forms gives some very interesting results:

(*a*) *M. capillaris* is a plant of dry sandy or rocky (eugeogenous) soils, but the leaf shows only feebly the strong xerophytic structure of *M. filipes*. Material from Great Falls, Md., was studied. Leaf thinner than in *M. filipes*, conduplicate when dry, but flat when well supplied with water. Ventral face not furrowed, furrows on the dorsal face extending nearly halfway through the leaf, with stomata at bottom.

Epidermis much as in *M. filipes*, but with bulliform cells between each 2 nerves; hairs much fewer than in *filipes*, all short, thick-walled, pointed, and prickle-like, occurring on the ventral face only above the nerves, on the dorsal face lining the stomata-bearing furrows and there thicker-walled, with hardly perceptible lumen.

Subepidermal stereome in flattened supporting strands above and below the mestome bundles, from which they are separated by thickish-walled, colorless parenchyma; and also in the leaf margins.

Chlorenchyma as in *filipes*, but entirely surrounding the smaller bundles, interrupted by colorless parenchyma above and below the larger ones. Also much chlorophyll in the cells of the parenchyma sheath which adjoin the chlorenchyma.

Mestome bundles with no true mestome sheath, but mostly surrounded by a sin-

SPARTINA PATENS (Ait.) Muhl.[1]

Leaf involute when dry, deeply furrowed between the nerves on the ventral face, high, broad, rounded ridges separating the larger

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gle row of mestome parenchyma with cell walls thinner than in *filipes* and evenly thickened; mestome parenchyma also in a single layer between hadrome and leptome, and, with a few of the companion cells of the leptome, isolated or in groups of 2 or 3, very thick-walled.

(*b*) *Muhlenbergia trichopodes* is a plant of low, often moist, pine barrens in the Gulf strip of the Austroriparian area. The example here described was collected in Mississippi. It is in several histological characters intermediate between *capillaris* and *filipes*, although morphologically the most distinct of the 3 species.

Leaf conduplicate when dry, nearly flat when supplied with abundant moisture. Ventral surface with only the 2 or 3 nerves nearest each margin prominent and separated by deep furrows, the others, including the midnerve, barely projecting. Dorsal surface with narrow and rather deep furrows between the nerves.

Epidermis: Ventral with single rows of short cells alternating with several rows of long ones; hairs, chiefly in the furrows, shorter, stouter, and thicker-walled than in *filipes;* bulliform cells much as in *capillaris*, rather thick-walled. Dorsal with rather thick-walled cells (less so than in *filipes*), single, quadrangular (from above), short ones alternating with longer ones; hairs short, stout, thick walled, prickle like.

Subepidermal stereome rather more strongly developed than in *capillaris* and *filipes*, in flattened supports above and below the mestome bundles (hence at summit of the ventral ridges), strongest on the dorsal side, where it interrupts the parenchyma sheath of the larger nerves; also in the margins.

Chlorenchyma with cells as in *filipes*, radially arranged in single layers about the bundles, entirely encircling the smaller ones, in the larger ones perpendicular to the leaf surface and extending to the stereome at the summits of the ventral ridges (as in *Spartina stricta* and *Uniola paniculata*); parenchyma sheath and the large parenchyma cells above the mestome bundles also containing chlorophyll where they adjoin the smaller-celled chlorenchyma.

Colorless parenchyma (rather thick-walled) filling the interior of the ridges, and in a single row of large cells between each 2 nerves, separating their respective bands of chlorenchyma.

Mestome bundles without a true mestome sheath, but the larger ones surrounded by a layer of mestome parenchyma which is much thicker-walled than in the 2 related species: around the smaller bundles the mestome parenchyma thinner-walled and interrupted by 2 large vessels of the hadrome; mestome parenchyma also in 1 layer between hadrome and leptome, as in the other 2 species.

The important leaf characters of these allied species of Muhlenbergia may be tabulated thus:

[The sign × indicates presence of character.]

Species.	Unrolling when wet.	Always conduplicate.	Deeply furrowed on ventral surface.	Not deeply furrowed.	Midrib greatly projecting on ventral surface.	Midrib only slightly projecting.	Bulliform cells present.	Bulliform cells none.	Subepidermal stereome on both faces and in margins.	Subepidermal stereome only on dorsal face; none in margins.	Much colorless parenchyma above the mestome bundles.	No colorless parenchyma above the mestome bundles.
Capillaris	×	......	......	×	......	×	×	......	×	......	......	×
Trichopodes	×	......	×	......	......	×	×	......	×	......	×	......
Filipes		×	×	......	×	......	......	×	......	×	×	......

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[1] Compare the figure of *S. versicolor* in Duval-Jouve, Étude Anat., *pl. 16, fig. 7.*

furrows, which are 2-cleft at bottom by the low ridges of the smaller nerves.

Epidermis: Ventral with cells much smaller and thinner-walled than on the dorsal surface; stomata on each side of the bottom of the furrows, somewhat prominent; many of the epidermal cells extended into short, rather thin-walled, erect, unicellular papillae with broad, rounded or truncate summits, and, especially at the summit of the ridges, into longer, sharp-pointed, thick-walled, erect, prickle-like hairs; typical bulliform cells none, but at the bottom of each furrow a group of usually 3 large epidermis cells, which are probably functionally homologous. Dorsal with thick, porous walls, which, in the rows containing stomata, are unevenly thickened so as to appear wavy, 1 or more often 2 short cells alternating with the longer ones; cuticle thick; stomata in very shallow furrows; hairs and papillae none.

Subepidermal stereome not as strongly developed as in most of the strand grasses, in small groups on the dorsal side of each nerve; in flattened supporting strands at the summit of each ventral rib and extending some distance down its sides; and in comparatively small strands in the leaf margins.

Chlorophyll chiefly in the parenchyma sheath of the mestome bundles, with a "bridge" of small-celled chlorenchyma connecting each two neighboring sheaths; palisade none.

Colorless parenchyma filling the ventral ribs above the mestome bundles where it interrupts the parenchyma sheath, a few cells also interrupting the parenchyma sheath on the dorsal side.

Mestome bundles surrounded by a mestome sheath whose walls (especially the inner) are much thickened only on the leptome side of the larger nerves; parenchyma sheath (enveloping the mestome sheath) containing chlorophyll, continuous about the smaller nerves, interrupted by colorless parenchyma above and below the larger ones; mestome parenchyma (thick-walled) in a single layer between the leptome and the hadrome of the larger bundles.

SPARTINA STRICTA (Ait.) Roth.[1]

Leaf conduplicate when dry, not furrowed on the dorsal surface, deeply furrowed on the ventral side, the furrows acute, the intervening ridges broad and truncate at summit.

Epidermis: Ventral with cells narrower and not so high as on the dorsal surface, the walls as in *S. patens*, except that the outer wall of each cell is covered with silicified papillae; stomata on each side of the bottom of the furrows; hairs none; typical bulliform cells none, but 1 to 3 epidermal cells at bottom of each ventral furrow somewhat larger than the others and probably functioning as bulliform cells. Dorsal as in *S. patens*, the short cells usually single, here and there rounded, with strongly thickened walls, almost forming papillae; stomata none; hairs none.

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[1] Although this species belongs to the salt marsh, it is described here for the sake of convenient comparison with the other Gramineae. Compare Duval-Jouve, Histotaxie, *pl. 18, fig. 5.* The Ocracoke plant is nearly of the typical form.

Hypodermal colorless parenchyma in a single layer beneath the dorsal epidermis,[1] interrupted by subepidermal stereome.

Stereome not strongly developed, a small subepidermal group on the dorsal side of each mestome bundle; flattened supporting strands (1 or 2 layers) at the summit of each ventral ridge, not decurrent along its sides; also in the leaf margins.

Chlorenchyma consisting of small palisade cells in a single layer, radially arranged on each side of each mestome bundle and extending immediately beneath the epidermis to the stereome at the summit of each ventral ridge; each 2 neighboring layers of palisade, between each two nerves, either adjoining or separated by a few, large, colorless parenchyma cells; chlorophyll also in most of the cells of the parenchyma sheath.

Mestome bundles with mestome sheath and mestome parenchyma much as in *S. patens*. Parenchyma sheath (around the mestome sheath) of large cells, those adjoining the palisade layer containing chlorophyll, the sheath occasionally interrupted on the dorsal side of the bundle by a few cells of the subepidermal stereome. Large parenchyma cells, in 2 or 3 layers, occupying the thickness of the ventral ridges and appearing to be an extension of the parenchyma sheath; when in 3 layers, the middle one colorless.[2]

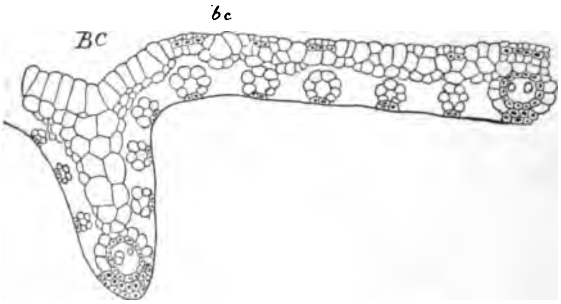

FIG. 5. *Chloris petraea*—leaf blade. Transverse section, showing the midrib in the keel, covered by layers of colorless tissue and a group of bulliform cells (BC) on the ventral surface; *bc*, a small group of bulliform cells between two mestome bundles. The mestome bundles are indicated by their parenchyma sheaths and by the stereome, which forms small subepidermal groups. The thick walled mestome sheath is drawn only in the two large bundles. Scale 84.

CHLORIS PETRAEA Sw.[3]

Leaf (fig. 5) becoming conduplicate when dry, strongly keeled on the dorsal face and slightly impressed ventrally opposite the midvein, with a large mestome bundle at the apex of and 3 smaller ones on each side of the keel. Hairs none.

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[1] The specimen figured by Duval-Jouve, loc. cit., has 2 or 3 layers.

[2] *Spartina stricta maritima* (Walt.) Scribn., the common form elsewhere along our Atlantic coast, is practically identical in leaf anatomy with *S. stricta* from Ocracoke, except in the following particulars: The epidermis cell walls on the dorsal surface are thinner and less porous and show less of the wavy thickening, the short cells are more often in pairs, and, when single, are more often papilliform; stereome is somewhat more strongly developed, as would be expected from the larger size of the plant and the greater length of the leaves. The material examined was from Lynnhaven Bay, Virginia.

[3] Figured by Duval-Jouve, Histotaxie, p. 355, *pl. 18, f. 1*. For an example of similar leaf structure compare the same author's paper, "Étude histotaxique des Cyperus de France," Mém. de l'Acad. de Montpellier, tome 7, *pl. 22, f. 6*. 1874.

Epidermis: Ventral, differentiated as bulliform cells in a rather wide band above the keel and in 2 small groups of about 4 cells each, 1 between the first pair of nerves on each side of the keel; elsewhere pluricellular (3 or 4 layers) and occupying more than one-half of the thickness of the leaf, except above the larger nerves, thin-walled (except the outer wall of the outermost layer) and large (except the single outermost layer where it lies above the subepidermal groups of stereome); stomata none. Dorsal (fig. 6), one-layered, with cells all small, the outer wall and cuticle much thickened, radial walls thin, undulate, one row of short cells with strongly silicified walls alternating with several rows of long ones, many of the cells developed into rounded, not silicified, papillae; stomata in the strips of epidermis which lie between the nerves, level with the epidermal surface.

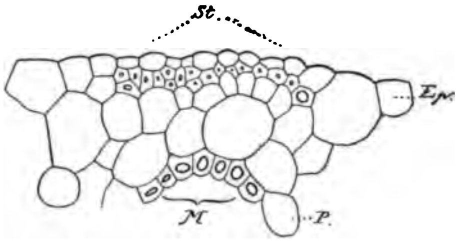

Fig. 6.—*Chloris petraea*—ventral portion of leaf blade. Transverse section, showing epidermis (*Ep*) and subepidermal stereome (*St*); at *M* the mestome sheath of a bundle, bordering on layers of colorless parenchyma. Scale 240.

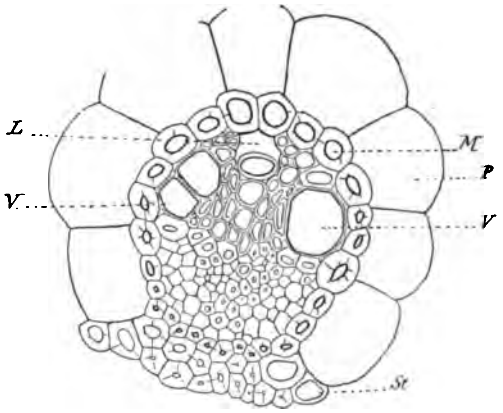

Fig. 7.—*Chloris petraea*—large mestome bundle from leaf blade. St, stereome of lower face of blade, bordering on the mestome sheath (M), which encircles both the leptome and hadrome as a closed sheath of thick-walled, porous cells. Bordering on the mestome sheath is a green parenchyma sheath (P). VV, vessels; L, lacune with an annular vessel. Scale 560.

Subepidermal stereome (fig. 6) in flattened supports above and below the mestome bundles, that on the ventral side in 1 or 2 layers above the larger nerves, reduced to small groups (sometimes only 2 cells) above the smaller ones; on the dorsal side supports stronger, sometimes 3-layered; also in the leaf margins.

Chlorenchyma, palisade, arranged radially in a single row of cells on each side of each mestome bundle, with a "bridge" of small-celled chlorenchyma, containing usually a few cells of colorless parenchyma, connecting each 2 neighboring rows; chlorophyll likewise in the parenchyma sheath where it adjoins the palisade.

Mestome bundles each inclosed by a mestome sheath (figs. 6, 7, 8) which has small cells with equally thickened walls; parenchyma sheath with large, thin-walled cells containing chlorophyll where they adjoin the palisade; mestome parenchyma in a single layer separating the hadrome from the leptome of the larger bundles; companion cells of the sieve tubes with much thickened walls.

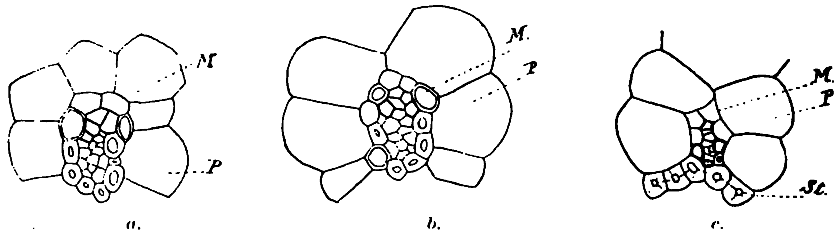

FIG. 8. *Chloris petraea*—three small mestome bundles from the blade. (Letters as in fig. 7.) In *a* the mestome sheath is thick-walled only on the leptome side; in *b* and *c* the thickening of the mestome sheath is more distinct and begins to show also on the hadrome side. The sheath is closed in all of these small bundles and is a true mestome sheath. Scale 560.

UNIOLA PANICULATA L.[1]

Leaf rather thick and hard, more or less involute when dry, deeply furrowed on the ventral surface, the intervening ridges broad and truncate or but slightly rounded at summit; dorsal surface with very slight corresponding depressions.

Epidermis: Ventral with cells smaller and thinner-walled than on the dorsal surface, the outer walls more arched, many of the cells, especially on the sides of the furrows, extended into short, stout, pointed, unicellular, antrorse, prickle-like hairs with cuticle rough and excessively thickened (lumen almost obliterated except toward the base); stomata near the bottom of the ventral furrows; bulliform cells in very small groups at the bottom of the furrows. Dorsal with conspicuously pitted walls and very thick,[2] strongly wrinkled cuticle, 1 or sometimes 2 or 3 short cells alternating in the same rows with long ones; hairs none; stomata less numerous than on ventral surface.

Stereome strongly developed (more so than in any other of these strand grasses); strong, flattened subepidermal supports at the summits of the ventral ridges, separated from the mestome bundles by thin-walled colorless parenchyma which also contains small, isolated groups of stereome; narrow, mostly 2-layered subepidermal groups on the dorsal side opposite the ventral furrows; strong subepidermal supports on the dorsal side of each mestome bundle; finally, strong marginal groups.

Chlorenchyma: Palisade small-celled, radially disposed on each side of each mestome bundle in single layers, which are perpendicular to the leaf surface and extend nearly to the summit of the ventral ridges; inside the layer of palisade, and parallel to it, is a single layer of large, thin-walled parenchyma cells containing chlorophyll, which represents an imperfect parenchyma sheath to the mestome bundles.

---

[1] Compare Holm, Bot. Gaz. vol. 16, *pl. 22, ff. 8 to 12*, 1891.

[2] But much less so than in Holm's material from Fort Monroe, Va.

Colorless parenchyma in several layers which lie below the ventral furrows and separate each two neighboring layers of palisade.

Mestome bundles without a true mestome sheath, but with the leptome surrounded by an unbroken ring of mestome parenchyma having small cells with thick porous walls.

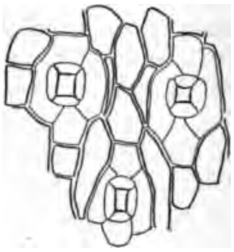

FIG. 9.—*Yucca aloifolia*—leaf surface. Epidermis, showing openings leading to the stomata. Scale 320.

YUCCA ALOIFOLIA L.

Leaf isolateral, thick, especially toward the base, ending in a rigid apical spine.

Epidermis (figs. 9 and 10) cells containing chlorophyll, mostly somewhat elongated parallel to the leaf axis, their walls, especially the arched outer ones, greatly thickened and, together with the massive cuticle, exceeding the cell lumen, the radial walls not undulate; cuticle sharply differentiated, beautifully stratified, divided by perpendicular lamellæ corresponding to the radial cell walls; stomata deeply sunken, lying beneath the cuticle at the bottom of urn-shaped passages whose outer orifice is quadrangular with raised, cushion-like borders, the ridges of exit at bottom of the pore very acute; papillæ none (perhaps present in younger leaves).

Interior of the leaf occupied by homogeneous, thin-walled parenchyma, which, toward the apex of the leaf, contains chlorophyll in its entire thickness.

Mestome bundles lying in several rows in the mesophyll, each surrounded by a parenchyma sheath.

Stereome in massive groups on both the leptome and the hadrome side of the bundles, especially strong on the hadrome side. Small bundles of stereome, each with a parenchyma sheath, are scattered among the mestome bundles.

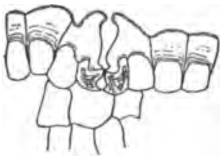

FIG. 10.—*Yucca aloifolia*—a stoma. Cross-section. Scale 320.

YUCCA GLORIOSA L.

Leaf much like the preceding.

Epidermis with larger (higher) cells; dorsal surface bearing thick, rounded, 1-celled papillæ.

Apical spine with exceedingly thick outer epidermis walls and cuticle, these much higher than the cell lumen, radial and inner walls also much thickened; next a hypodermal layer of thick-walled collenchyma; then 1 or 2 layers of thick-walled collenchymatic tissue; and, finally, a dense mass of stereome, inclosing a small central mestome bundle.

MYRICA CAROLINENSIS Mill.[1]

Leaf bifacial, thickish, both surfaces sprinkled with resiniferous glands, appearing to the unaided eye as granules of resin.

Epidermis: Ventral, cells small, radial walls not undulate; cuticle thick, smooth; stomata none; long, pointed, unicellular hairs with thick-walled, smooth cuticle scattered along the veins; short-stalked, superficially flat, scale-like, pluricellular glands occupying deep depressions but usually rising above the level of the epidermis, these filled with a mass of bright-yellow resin which breaks down the cell walls and finally itself disorganizes, the stalk of each gland radially surrounded by numerous small foot cells. Dorsal similar, but cuticle less thickened, glands less numerous, and stomata present, lying in all directions, each surrounded by 5 to 7 ordinary epidermis cells, the guard cells slightly prominent.

Chlorenchyma sharply differentiated into one very compact layer of palisade with high, narrow cells, and several layers of open pneumatic tissue with rather large intercellular spaces.

Colorless thin-walled parenchyma in narrow plates interrupting the chlorenchyma above and below the smaller veins.

Hypodermal collenchymatic tissue, thick-walled, in 2 or 3 layers above and below the midvein.

Mestome bundles of midvein reinforced by stereome which adjoins both the hadrome and the leptome, that below the leptome separated from the hypodermal collenchymatic tissue by a little thin-walled parenchyma.

MYRICA CERIFERA L.

Leaf usually somewhat thinner than in *M. carolinensis.*

Epidermis similar, but with fewer hairs along the veins.

Palisade somewhat thicker, in 2 layers of lower cells.

QUERCUS VIRGINIANA L.[2]

Leaf persistent, thick, bifacial, upper surface shining, margins sometimes revolute, veins, especially the midvein, prominent beneath.

Epidermis: Ventral with nonundulate cell walls, the outer, especially, strongly thickened; cuticle thick, smooth; stomata none; hairs none. Dorsal, cell walls as on the ventral surface; stomata with guard cells slightly prominent, lying in all directions, each bordered by several small epidermis cells; hairs (fig. 11) forming a dense covering, stellate, consisting of 8 to 18 acute, thick-walled unicellular arms upon very narrow foot cells, cohering toward their bases so as to form a saucer-shaped scale.

---

[1] Material examined from near Norfolk, Va.

[2] *Q. virens Ait.* Material examined was from near Norfolk, Va. Compare *Quercus ilex* as described and figured by Lalanne, Recherches, p. 3, *pl. 7, ff. 9, 12.*

Hypoderm mostly 2-layered, collenchymatic, continuous on both surfaces (rarely interrupted by palisade), replacing the chlorenchyma and forming thick masses above and especially below the midvein.

Stereome thin-walled, in narrow plates interrupting the chlorenchyma and extending through the leaf opposite most of the smaller veins; in strong masses above and below the midvein.

Chlorenchyma: Palisade compact, mostly in 2 layers, passing gradually into *pneumatic tissue* of which only the lowest layer is comparatively open and short-celled.[1]

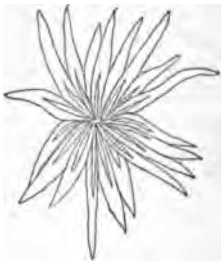

FIG. 11.—*Quercus virginiana*—stellate hair from dorsal leaf surface. Viewed from above. Scale 270.

ZANTHOXYLUM CLAVA-HERCULIS L.[2]

Leaf bifacial, thickish, dark green and shining above.

Epidermis: Ventral, cells large, walls not undulate, the outer strongly thickened, the others thin; cuticle sharply defined, delicately wrinkled; stomata none; hairs none. Dorsal, cells smaller, the outer walls and cuticle thinner; stomata with guard cells slightly prominent, lying in all directions, surrounded by 4 to 6 epidermis cells; hairs none.

Hypodermal collenchyma with strongly thickened walls in 4 or 5 narrow layers above the midvein; collenchymatic tissue in 4 or 5 wide layers beneath the midvein.

Chlorenchyma: Palisade a single compact layer of short cells; pneumatic tissue in 2 or 3 layers, rather open.

Oil reservoirs schizolysigenous,[3] scattered through the mesophyll near the ventral surface, and larger ones at the base of each indentation of the leaf margin, surrounded by 2 or 3 layers of thickish-walled parenchyma with cells strongly compressed parallel to the surface of the cavity.

Mestome bundles surrounded by a thin, interrupted sheath of stereome, which is continuous and (in cross section) crescent-shaped outside the leptome.

---

[1] *Quercus laurifolia* Michx. is a deciduous-leaved species, common along the coast and perhaps occurring upon Ocracoke Island. Leaves from Cape Henry, Va., show the following differences from *Q. virginiana:*

Epidermis: Cuticle thicker; dorsal surface less densely covered with similar stellate hairs, their arms longer, more slender and much thinner-walled.

Collenchymatic hypoderm none except above the midvein. True *collenchyma* (hypodermal) strongly developed beneath the midvein.

Stereome entirely surrounding the midvein, where it is much thicker-walled than in *virginiana.*

Chlorenchyma: Only the uppermost layer typical palisade; pneumatic tissue more compact and with more elongated cells than in *virginiana.*

[2] Material from Virginia and Mississippi.

[3] Compare Solereder, Syst. Anat., p. 201.

CROTON MARITIMUS Walt.

Leaf flat, bifacial, both surfaces densely covered with a gray, scale-like pubescence.

Epidermis: Ventral, cells small, walls not undulate, thin; stomata very numerous, guard cells level with the epidermis, each stoma surrounded by 4 epidermal cells, of which 2 are differentiated as crescent-shaped subsidiary cells parallel with the guard cells; hairs pluricellular, stellate, consisting of a long cylindrical stalk rising above the surface and composed of many small cells partly of subepidermal origin, from the apical cell of which radiate in a nearly horizontal plane numerous unicellular, sharp-pointed arms with thick, smooth cuticle, cohering near their bases so as to form a shallow cup. Dorsal, similar; cuticle thickened and granular underneath the large veins; stomata about equally numerous; hairs (fig. 12) with less numerous and thinner-walled arms.

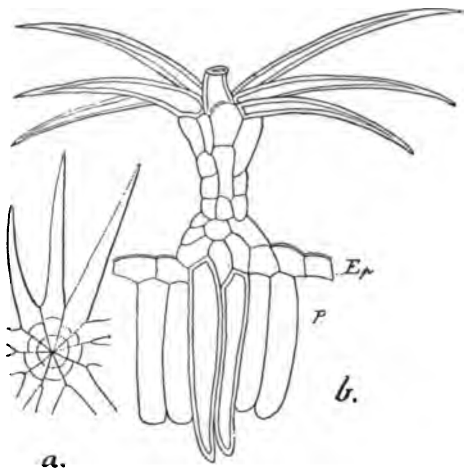

FIG. 12.—*Croton maritimus*—hair from dorsal leaf surface. *a*, View from above; *b*, cross section; Ep, epidermis; P, palisade. Scale 240.

Hypoderm, none, except beneath the large veins, where several layers of thin-walled collenchymatic tissue occur.

Stereome, none.

Chlorenchyma: Palisade in one layer, compact, the cells elongated, interrupted only by thick-walled, branching, sclerotic idioblasts; pneumatic tissue of roundish cells.

ILEX VOMITORIA Ait.

Leaf evergreen, thick, shining and dark green above, bifacial.

Epidermis: Ventral, cells rather high (but small in their diameter parallel to the leaf-surface), the outer wall and cuticle much thickened but not nearly so high as the cell lumen, radial walls rather thin, undulate; cuticle smooth; stomata none; erect, short, stout, pointed, often curved, prickle-like unicellular hairs with very thick walls (lumen almost obliterated) and smooth cuticle along the mid-vein.[1] Dorsal, cells smaller, thicker-walled (outer wall and cuticle exceeding the cell lumen in height), the radial walls nearly straight, porous; cuticle wrinkled; stomata very numerous, guard cells slightly depressed; hairs, none.

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[1] This species is, therefore, an exception to the rule that evergreen leaves have no hairs on the upper or ventral surface. (See Lalanne, p. 117.)

Hypodermal collenchymatic tissue in a single narrow layer above the midvein (as in *I. opaca*) and several layers beneath the midvein.

Chlorenchyma: Palisade in two layers; pneumatic tissue rather open (more so than in *I. aquifolium* and *I. opaca*).

Mestome bundle of midvein reinforced by a narrow group of stereome below the leptome, and a thinner-walled group above the hadrome.[1]

OENOTHERA HUMIFUSA Nutt.

Leaf densely silky-pubescent, imperfectly bifacial, midvein slightly impressed above, not prominent beneath.

Epidermis similar on both surfaces, cell walls not undulate, somewhat thickened, especially the outer; cuticle smooth; stomata with guard cells level with the upper surface, slightly prominent beneath, the majority lying parallel to the veins, but many irregular; hairs densely matted, subappressed, long, sharp-pointed, unicellular, with thick, granular cuticle, each radially surrounded by 5 or 6 foot cells.

Hypodermal collenchyma in 2 narrow layers above and 1 wide layer beneath the midvein, separated from the mestome above and below by colorless (water-storage?) parenchyma.

Stereome, none.

Chlorenchyma not sharply differentiated; palisade containing large cells inclosing raphides, which are yet more abundant in the otherwise rather compact pneumatic tissue.

TEUCRIUM NASHII Kearney.[2]

Leaf normally horizontal, bifacial, dark green above, white-tomentous beneath, margins (especially in young leaves) somewhat revolute, veins impressed above, prominent and reticulated beneath.

Epidermis: Ventral, cell walls thin, the lateral not undulate or but very slightly so; cuticle smooth; stomata, none; hairs scattered, mostly 3 or 4 celled, thin-walled, smooth, slender, very sharp-pointed, strongly bent so as to lie nearly parallel to the surface, surrounded radially by 4 to 10 (most frequently 6) foot cells. Dorsal, cell walls more undulate; stomata in the sheltered interstices between the projecting veins, with guard cells slightly prominent, lying in all directions, usually bordered by 2 epidermal cells and at right angles to their dividing wall, but with many exceptions; long-pointed hairs forming a dense covering; also very numerous, spherical, sessile, glandular hairs with roughened cuticle.

Hypodermal collenchymatic tissue in 2 or 3 narrow layers above and

---

[1] Specimens cultivated at Washington, D. C., differ in having 3 layers of palisade, and no stereome above the hadrome of the midvein.

[2] *Teucrium canadense*, which is never, to my knowledge, a strand plant, differs chiefly in the less dense hairy covering of the dorsal leaf surface and in the distinct granular roughening of the cuticle in the pointed, as well as the glandular hairs.

1 wide layer beneath the midvein, the latter separated from the leptome by several layers of colorless parenchyma.

Stereome, none.

Chlorenchyma: Palisade a single layer of short cells, very compact; pneumatic tissue occupying the rest of the leaf's thickness, also rather compact.

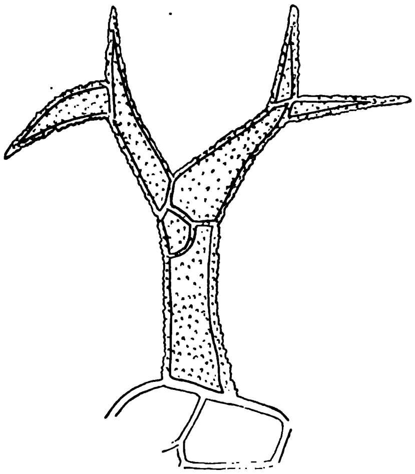

FIG. 13.—*Physalis viscosa*—branched hair from leaf. Scale 240.

PHYSALIS VISCOSA L.

Leaf flat, thin, imperfectly bifacial, gray-canescent or green (depending upon the amount of pubescence).[1]

Epidermis similar on both faces, cell walls not thick, the radial undulate; cuticle above and beneath the veins thick and warty; stomata much more numerous on the dorsal surface; hairs (fig. 13) about equally numerous on both faces, thin-walled with granular cuticle, consisting of a unicellular stalk bearing 3 or 4 (usually 3) conical, acute, unicellular or sometimes bicellular arms, these in turn sometimes once-branched.

Hypodermal collenchymatic tissue above and beneath the veins.

Stereome, none.

Chlorenchyma: Palisade and pneumatic tissue not well differentiated, both compact.

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[1] The individuals observed upon Ocracoke Island had greener, less pubescent leaves than at Cape Henry, Va.

Leaf anatomy of sand-strand species.

[The sign × indicates presence of character; ± its imperfect development.]

Species.	Leaf.				Epidermis.				
					Cuticle				
	Bifacial.	Isolateral.	Relatively thick.	Conduplicate or involute when dry.	Thick.	Wrinkled.	Warty or granular.	Radial cell-walls undulate.	Bulliform cells present.
Panicum amarum	×	......	×	×	×	......	......	......	×
Muhlenbergia filipes	×	......	×	×	×	......	......	......	......
Spartina patens	×	......	×	×	×	......	......	......	......
Spartina stricta[1]	×	......	×	×	×	......	×	......	......
Chloris petraea	×	......	......	×	×	......	......	×	×
Uniola paniculata	×	......	×	×	×	×	......	......	×
Yucca aloifolia	......	×	×	......	×	......	......	......	......
Yucca gloriosa	......	×	×	......	×	......	......	......	......
Myrica carolinensis	×	......	......	......	×	......	......	......	......
Myrica cerifera	×	......	......	......	×	......	......	......	......
Quercus virginiana	×	......	×	......	×	......	......	......	......
Zanthoxylum clava-herculis	×	......	×	......	×	×	......	......	......
Croton maritimus	×	......	......	......	......	......	±	......	......
Ilex vomitoria	×	......	×	......	×	×	......	×	......
Oenothera humifusa	×	......	......	......	......	......	......	......	......
Teucrium nashii	×	......	......	......	......	......	......	±	......
Physalis viscosa	×	......	......	......	......	......	×	×	......

Species.	Epidermis.									
	Stomata.									
	Both surfaces.	Ventral surface only.	Dorsal surface only.	Prominent.	Level with surface.	Sunken.	In furrows.	Parallel to leaf axis.	Irregularly disposed.	Subsidiary cells present.
Panicum amarum	×	......	......	......	......	......	×	×	......	......
Muhlenbergia filipes	×	......	......	......	......	......	×	×	......	......
Spartina patens	×	......	......	......	......	......	×	×	......	......
Spartina stricta	......	×	......	......	......	......	×	×	......	......
Chloris petraea	......	......	×	......	×	......	......	×	......	......
Uniola paniculata	×	......	......	......	......	......	×	×	......	......
Yucca aloifolia	×	......	......	......	......	×	......	×	......	......
Yucca gloriosa	×	......	......	......	......	×	......	×	......	......
Myrica carolinensis	......	......	×	×	......	......	......	......	×	......
Myrica cerifera	......	......	×	×	......	......	......	......	×	......
Quercus virginiana	......	......	×	×	......	......	......	......	×	......
Zanthoxylum clava-herculis	......	......	×	×	......	......	......	......	×	......
Croton maritimus	×	......	......	......	×	......	......	......	......	×
Ilex vomitoria	......	......	×	......	......	×	......	......	......	......
Oenothera humifusa	×	......	......	×	×	......	......	×	......	......
Teucrium nashii	......	......	×	×	......	......	......	......	×	......
Physalis viscosa	×	......	......	......	......	......	......	......	......	......

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[1] Belongs to the Salt Marsh, but is inserted here for convenience of comparison with other Gramineae.

Leaf anatomy of sand-strand species—**Continued.**

Species.	Epidermis.										Hypodermal collenchyma or collenchymatic tissue.	
	Hairs.											
	Both surfaces.	Ventral surface only.	Dorsal surface only.	Forming a dense covering.	Unicellular.	Pluricellular.	Simple.	Branching.	Stellate.	Glandular hairs or scales.	Only opposite veins.	Elsewhere.
Panicum amarum	......	......	......	......	......	......	......	......	......	......	......	......
Muhlenbergia filipes	×	......	......	......	×	......	×	......	......	......	......	......
Spartina patens	......	×	......	......	×	......	×	......	......	......	......	......
Spartina stricta	......	......	......	......	......	......	......	......	......	......	......	......
Chloris petraea	......	......	......	......	......	......	......	......	......	......	......	......
Uniola paniculata	......	×	......	......	×	......	×	......	......	......	......	......
Yucca aloifolia	......	......	......	......	......	......	......	......	......	......	......	......
Yucca gloriosa	......	......	......	......	......	......	......	......	......	......	......	......
Myrica carolinensis	×	......	......	......	×	×	×	......	......	×	×	......
Myrica cerifera	×	......	......	......	×	×	×	......	......	×	×	......
Quercus virginiana	......	......	×	×	......	×	......	......		......	......	×
Zanthoxylum clava-herculis	......	......	......	......				......	......	......	×	......
Croton maritimus	×	......	......	×	......	×	......	......	×	......	×	......
Ilex vomitoria	......	×	......	......	×	......	×	......	......	......	×	......
Oenothera humifusa	×	......	......	×	×	......	×	......	......	......	×	......
Teucrium nashii	×	......	......	×	×	......	×	......	......	×	×	......
Physalis viscosa		......	......	×	......	×	......	×	......	......	×	......

Species.	Stereome.			Chlorenchyma.						Water parenchyma.		Mestome bundles.	
	Subepidermal.	In leaf margins.	Adjoining mestome bundles.	Homogeneous.	Differentiated.	Palisade compact.	Palisade interrupted by water parenchyma.	Chlorenchyma radially arranged about mestome bundles.	Occupying the interior of the leaf.	Chiefly opposite mestome bundles.	With mestome sheath.	With parenchyma sheath.
Panicum amarum	×	×	......	×	......	×	......	×	......	......	×	×
Muhlenbergia filipes	×	......	......	×	......	......	......	×	......	×	......	×
Spartina patens	×	×	......	×	......	......	......	×	......	×	×	×
Spartina stricta	×	×	......	×	......	×	......	×	......		×	×
Chloris petraea	×	×	......	×	......	×	......		......	......	×	×
Uniola paniculata	×	×	......	×	......	×	......	×	×	......	......	×
Yucca aloifolia	......	......	×	×	......	......	......	......	×	......	......	×
Yucca gloriosa	......	......	×	×	......	......	......	......	×	......	......	×
Myrica carolinensis	......	......	×	......	×	×	......	......	......	×	......	......
Myrica cerifera	......	......		......		×	......	......	......	×	......	......
Quercus virginiana	......	......	×	......		×	......	......	......	......	......	......
Zanthoxylum clava-herculis	......	......	×	......	×	×	......	......	......	......	......	......
Croton maritimus	......	......	......	......		×	......	......	......	......	......	......
Ilex vomitoria	......	......	×	......		×	......	......	......	......	......	......
Oenothera humifusa	......	......	......	......	×	......	......	......	......	×	......	......
Teucrium nashii	......	......	......	......	×		......	......	......	......	......	......
Physalis viscosa	......	......	......	......		×	......	......	......	......	......	......

SALT MARSH SPECIES.

TRIGLOCHIN STRIATA Ruiz & Pav.

Leaf isolateral, thickish.

Epidermis cells with nonundulate walls, the outer strongly thickened; cuticle thick, granular; stomata in rows parallel to the nerves, level with the surface, each bordered by 4 epidermal cells, of which 2 are subsidiary and resemble the guard cells; hairs none.

Stereome none.

Chlorenchyma: Two outer layers compact, continuous on both surfaces, not palisadic except at the leaf margins, where 3 layers of palisade occur; parenchyma of the interior of the leaf containing little chlorophyll, interrupted by lacunes.

Mestome bundles imbedded in the interior parenchyma, each surrounded by a small-celled mestome sheath, whose inner walls are excessively thickened and layered; this surrounded by a sheath of large-celled, colorless parenchyma.

SPARTINA STRICTA (Ait.) Roth.

Treated for comparison among sand-strand grasses, page 29.

JUNCUS ROEMERIANUS Scheele.

Leaf vertical, terete, sharp-pointed, stem-like.

Epidermis cells all small, quadrangular (superficially), regular, without alternation of long and short cells; smaller and thicker-walled over the bands of chlorenchyma than over those of subepidermal stereome, the outer walls much thickened and porous; stomata[1] with guard cells level with the other epidermal cells; hairs none.

Stereome (subepidermal) alternating with the chlorenchyma in strong groups, which in cross section are I-shaped.[2]

Chlorenchyma of typical long, narrow palisade cells, mostly in 5 or 6 layers.

Mestome bundles arranged in several concentric circles, completely surrounded by stereome (which is particularly strong on the two sides parallel to the leaf surface), the whole enveloped by a beautifully regular, large-celled parenchyma sheath. Within the stereome the bundle is encircled by a mestome sheath of small, thick-walled cells. The outer mestome bundles, with the colorless parenchyma between, form a continuous ring, unbroken by lacunes. The inner bundles lie in thin longitudinal plates of parenchyma, which separate large lacunes. Small bundles of stereome, each surrounded by a parenchyma sheath, also occur in the interior of the leaf.

Stem differing but little from the leaf; difference consisting chiefly in the presence of a cortex of some thickness, and in the less elongated chlorenchyma cells.

---

[1] Of the type common in Juncaceae, Cyperaceae, and Gramineae.

[2] "I-förmige Träger" of Schwendener.

SESUVIUM MARITIMUM (Walt.) B.S.P.[1]

Leaf isolateral, somewhat succulent.

Epidermis cells with nonundulate, radial walls, the outer somewhat thickened, some of the cells much larger and probably serving for water storage; cuticle smooth; stomata lying in all directions, guard cells level with the epidermis, each stoma bordered by 3 to 6 (usually 4 or 5) undifferentiated epidermis cells; hairs none.

Stereome none.

Chlorenchyma homogeneous and occupying the entire thickness of the leaf, interrupted by large intercellular spaces, which lie beneath the large (water-storage) epidermal cells.

Mestome bundles with a small group of collenchyma on the leptome side.

Stem: Epidermis with cell walls, especially the outer, strongly thickened. Stereome none. Collenchyma in small groups above the leptome of the primary mestome bundles. Cells containing crystal masses in the pith and a few in the cortex.

TISSA MARINA (L.) Britton.[2]

Leaf isolateral, hemicylindric, furrowed, margins sparsely ciliate, especially toward base.

Epidermis with cells somewhat elongated parallel to the leaf axis, the radial walls strongly undulate, the outer walls slightly thickened; stomata always parallel to the leaf axis, guard cells slightly prominent, lying usually between 2 ordinary epidermis cells and at right angles to their dividing wall, but sometimes bordered by 3 cells; hairs (on the margins) glandular (fig. 14), capitate, with a 3 or 4 celled stalk.

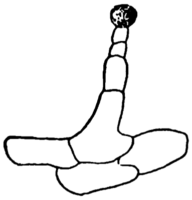

FIG. 14.—*Tissa marina*—glandular hair from leaf margin. Scale 240.

Stereome none.

Chlorenchyma compact, its cells not elongated.

Colorless parenchyma (water tissue) constituting the interior mesophyll.

Mestome bundle of the midvein small, lying deep in the water tissue, with a small group of collenchyma outside the leptome.

Stem: Epidermis with thick outer cell walls and wrinkled cuticle. Outer cortex separated from the inner by an unbroken, 2-layered ring of stereome, with cell walls (especially of the inner layer) comparatively thin.

---

[1] *Sesuvium pentandrum* Ell.—Compare Warming's description and figure of *S. portulacastrum*, Halofyt Studier. pp. 180, 211.

[2] *Spergularia salina* J. and C. Presl.

KOSTELETZKYA VIRGINICA (L.) A. Gray.

Leaf broad and flat, bifacial, stellate-pubescent on both surfaces.

Epidermis cells with nonundulate, thin walls, except above and below the larger veins, where the cuticle is rather thick and layered; stomata with guard cells slightly prominent, more numerous on the dorsal surface; hairs stellate, consisting of 5 to 8 acute unicellular arms with thick, smooth cuticle, separate nearly or quite to the base, each from a narrow foot cell in the epidermal plane.

Hypodermal collenchyma strongly developed above and below the larger veins.

Chlorenchyma: Palisade 1-layered; pneumatic tissue with numerous small intercellular spaces; mucilage cavities distributed in the chlorenchyma.

Mestome bundles almost completely surrounded by a thin, interrupted sheath of stereome, which is most strongly developed outside the leptome.

AMMANIA KOEHNEI Britton.

Leaf flat, rather thin, approximately isolateral.

Epidermis: Cells with radial walls strongly undulate; all the walls thin, except above and below the larger veins, where the outer walls are considerably thickened; cuticle smooth; hairs none; stomata chiefly parallel with the veins, but some irregular; guard cells slightly prominent, each stoma bordered by usually 4 undifferentiated epidermal cells.

Collenchyma none.

Stereome none.

Chlorenchyma homogeneous, not palisadic.

VINCETOXICUM PALUSTRE (Pursh) A. Gray.[1]

Leaves narrow, sharply reflexed and hanging almost vertically, imperfectly isolateral.

Epidermis: Cell walls rather thick, not undulate; cuticle wrinkled, especially above and below the veins; stomata more numerous on the ventral surface, level with the epidermis, each bordered by 4 or (more often) 5 ordinary epidermis cells, generally parallel with the leaf axis on the ventral surface, very irregularly disposed, often at right angles to the axis on the dorsal surface; hairs none.

Hypoderm a single, narrow layer, only above the midrib.

Collenchyma none.

Stereome none.

Chlorenchyma not palisadic, homogeneous through the leaf, but the interior containing less chlorophyll.

Cells containing masses of crystals (calcium oxalate) scattered in the chlorenchyma.

Stem: Epidermis as in the leaf.

---

[1] *Seutera maritima* Decsne.

Hypoderm continuous, 1-layered. Outer cortex with rather thick-walled cells, containing chlorophyll; inner cortex gradually becoming thinner-walled and colorless.

Stereome in a concentric band of isolated groups, lying inside the middle of the cortex.

Lactiferous ducts few, lying just outside the mestome bundles.

Mestome bundles bicollateral, perileptomatic, the leptome most strongly developed on the outer periphery of the hadrome.

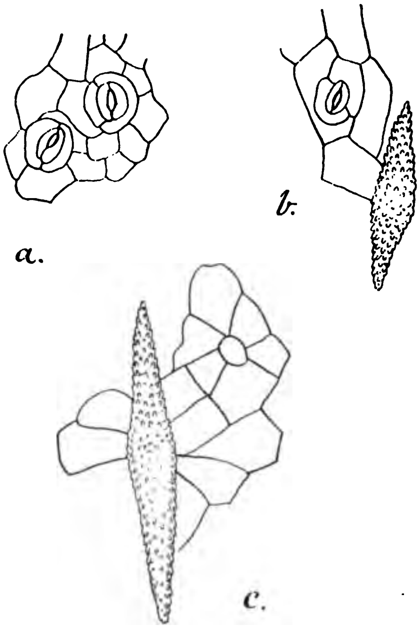

FIG. 15.- *Lippia nodiflora* -stomata and hairs. *a*, Stomata on leaf; *b*, hair and stoma on ventral leaf surface; *c*, hair on dorsal surface. Scale 240.

LIPPIA NODIFLORA Mx.

Leaf[1] imperfectly bifacial, usually horizontal, but sometimes vertical.

Epidermis alike on both surfaces, cell walls thick, not undulate; cuticle wrinkled; stomata (fig. 15) lying in all directions, guard cells almost level with the ventral surface, slightly depressed on the dorsal surface, each stoma bordered by 2 crescent-shaped, chlorophyll-holding, subsidiary cells which are usually at right angles to but often nearly or quite parallel to the guard cells, and of which one is usually considerably larger than the other; hairs abundant on both faces, parallel to the veins, appressed, lying in slight grooves of the epidermis, each attached by its middle (hence 2-armed) to a short cylindrical foot cell, which is bordered by several wedge-shaped (as seen from above) radially arranged epidermis cells, the free cell with a very thick, warty cuticle.

Hypodermal collenchyma (not very typical), in 1 or 2 layers above and 3 or 4 below the principal veins, interrupting the chlorenchyma in full-grown leaves.

Chlorenchyma: Palisade 2-layered, the cells rather short; pneumatic tissue rather compact, not well differentiated from the palisade, but its cells more nearly isodiametric and containing less chlorophyll.

Mestome bundles (of larger veins), with some stereome below the leptome and a small group of collenchyma above the hadrome, which finally becomes continuous with the subepidermal group of collenchyma.

---

[1] Compare Warming, Halofyt-Studier, p. 233, and Solereder, Syst. Anat., p. 718.

MONNIERA MONNIERA (L.) BRITTON.[1]

Occurs in 2 forms; one in shallow pools, largely submersed, with long stems, elongated internodes, and larger leaves; the other terrestrial, in wet sand, with short, creeping stems, contracted internodes and smaller leaves.

(*a*) Aquatic form. Structure that of a partially submersed hydrophyte, with thin-walled tissues, much reduced mestome system, no mechanical tissue, etc.

Leaf isolateral.

Epidermis: Cells with undulate lateral walls, the walls thin except the outer, which is somewhat thickened; cuticle delicately wrinkled; stomata more numerous on the dorsal surface, guard cells about level with the epidermis, bordered by 2 to 4 ordinary epidermal cells; hairs none.

Chlorenchyma homogeneous, palisade none.

Mestome bundles immediately bordered by chlorenchyma, not reinforced by stereome or collenchyma.

Stem: Epidermis as in the leaf.

Cortical parenchyma in 1 or 2 continuous layers just beneath the epidermis and around the central cylinder, elsewhere in 1-layered plates, separating the large lacunes.

Mestome cylinder composed of several bundles, inclosing a small quantity of pith.

(*b*) Terrestrial form. The only tangible differences from the aquatic form are: Stomata about equally numerous on both leaf surfaces; mestome bundles somewhat more developed and walls of the vessels more lignified; mesophyll somewhat more compact.

SOLIDAGO SEMPERVIRENS L.[2]

Leaf somewhat fleshy, vertical or nearly so, approximately isolateral.

Epidermis: Cells with nonundulate radial walls, only the outer strongly thickened, except above and below the larger veins; cuticle strongly wrinkled; stomata numerous on both faces with guard cells level with the surface, bordered by usually 4 ordinary epidermal cells; hairs none.

Hypodermal collenchyma in only 1 or 2 narrow layers above and 3 or 4 wide layers below the larger veins.

Chlorenchyma homogeneous, none of it typical palisade, frequently interrupted, especially opposite the mestome bundles, by plates of colorless, thin-walled parenchyma (water tissue), which extend from the ventral to the dorsal epidermis, and ultimately break down into large lacunes close beneath the epidermis.

---

[1] *Herpestis monniera* H. B. K.

[2] The material examined was collected at Virginia Beach, Va.

Ducts (probably resiniferous) numerous, especially near the dorsal surface, apparently always lying in the plates of water tissue, one below the leptome of the midvein.

Mestome bundles of the larger veins with a narrow (in transverse section crescent-shaped) group of comparatively thin-walled stereome above the hadrome.[1]

ASTER TENUIFOLIUS L.

Leaves narrow, almost vertical, isolateral, thick, with a deep groove on the dorsal surface on each side of the midvein, margins slightly incurved.

Epidermis: Cells comparatively large, walls not undulate, the outer greatly thickened; cuticle wrinkled and with slight furrows corresponding to the radial walls of the epidermal cells; stomata rather few and large, the guard cells slightly sunken, mostly somewhat deflected in direction from that of the leaf axis, bordered by usually 3 ordinary epidermis cells; hairs none.

Hypodermal collenchyma in a few narrow layers above and rather wide layers below the midvein.

Chlorenchyma consisting of palisade with high, narrow cells, in about 2 layers on both faces, strongly converging toward the midvein, especially on the ventral side.

Colorless parenchyma (water-storage tissue) occupying the interior of the leaf in small quantity, and surrounding the midvein, where it replaces the palisade.

Mestome bundles not reinforced by stereome.

ASTER SUBULATUS Michx.

Leaves wider and thinner than in the preceding, almost vertical, isolateral, flat, impressed above the midvein, which below is prominent, with a furrow on each side of it.

Epidermis: Cell walls not undulate, thick, the outer very thick, the inner collenchymatic-thickened where hypodermal collenchyma occurs; cuticle wrinkled; stomata, with guard cells lying parallel to the leaf axis, level with the surface; hairs none.

Hypodermal collenchyma above and below the veins (about 4 layers between the leptome of the midvein and the dorsal epidermis) and in the marginal angles.

Chlorenchyma of compact palisade, occupying practically the entire thickness of the leaf except where collenchyma occurs and about the midvein.

---

[1] The leaves of nonmaritime species of Solidago (e. g., *S. petiolaris*, *S. neglecta*, and *S. erecta*) exhibit some interesting differences from *S. sempervirens*. All three have bifacial leaves with compact palisade and open pneumatic tissue (chlorenchyma least differentiated in *S. petiolaris*). Stomata few (*S. erecta*, *S. neglecta*) or none (*S. petiolaris*) on the ventral surface, guard cells slightly prominent on the dorsal surface. Hairs along the veins, especially on the dorsal face in *S. petiolaris*, 3 or 4 celled, sharp-pointed, bent.

Colorless parenchyma (water-storage tissue) above and on each side of the midvein.

Mestome bundles without stereome supports, but with a small irregular group of collenchyma lying outside the hadrome.[1]

BACCHARIS HALIMIFOLIA L.

Leaves thickish, nearly vertical, isolateral.

Epidermis: Cell walls not undulate, thickened, the outer ones greatly so; cuticle warty, especially on the dorsal surface; stomata mostly parallel to the veins, but many somewhat deflected, guard cells slightly prominent, each stoma radially bordered by 4 or 5 small epidermis cells.

Collenchyma (hypodermal) replacing chlorenchyma above and below the larger veins (6 or 7 layers below the leptome of the midvein), containing no ducts.[2]

Chlorenchyma: Palisade occupying the whole thickness of the leaf between the veins, rather open, especially that in the interior of the leaf (but typical pneumatic tissue none), converging toward the midvein on the dorsal side; large, deep air chambers underneath the stomata.

Colorless parenchyma (water tissue) in 2 layers on each side of the midvein (cells circular in cross section), in a single layer entirely surrounding the smaller bundles.

---

[1] Three nonmaritime species of Aster were selected for comparison with the two salt-marsh species: *A. puniceus*, a broad-leaved plant of boggy ground, and *A. dumosus* and *A. ericoides*, narrow-leaved species of dry, sandy soil.

A. ericoides has a practically isolateral leaf, epidermis alike on both faces, with undulate radial and thickened outer walls, finely wrinkled cuticle, guard cells of the stomata level with the ventral surface, slightly prominent on the dorsal surface; chlorenchyma near both surfaces compact and small-celled, more open and larger-celled in the interior of the leaf; hypodermal collenchyma in 2 layers above and below the midvein; water parenchyma none.

A. dumosus has a distinctly bifacial leaf, epidermis much as in *A. ericoides*, but the 2 surfaces more differentiated, the ventral with radial cell walls less undulate and outer walls less thickened than in *A. ericoides*, cells larger and stomata much fewer on the ventral surface, the dorsal with radial walls more strongly undulate, and scattered, slender, pointed, few-celled hairs along the veins; palisade compact, pneumatic tissue open: veins supported by hypodermal collenchymatic tissue.

A. puniceus shows, of course, the greatest amount of difference from the salt-marsh forms. It has a flat, approximately horizontal, bifacial leaf. The ventral surface is rough with thick-walled, prickle-like, 1-celled hairs, mixed with scattered, longer, more slender, and thinner-walled hairs; the stomata lie in all directions in and have their guard cells level with the dorsal surface, but are wanting on the ventral face; the cuticle is smooth; the chlorenchyma is differentiated into a single layer of compact palisade and a few layers of rather open pneumatic tissue: no colorless parenchyma occurs inside the epidermis.

On the whole the salt-marsh Asters show less anatomical divergence from inland forms than does the salt-marsh Solidago. Of the two species, *A. tenuifolius* exhibits a more distinctive halophytic, or rather xerophytic, structure than does *A. subulatus*.

[2] Warming, Halofyt-Studier, p. 195, describes ducts which occur in the collenchyma of the leaf of *Baccharis dioica*.

Mestome bundles with a strong group of stereome only outside the hadrome in young leaves, in older leaves a corresponding group of more numerous and smaller cells outside the leptome also.

IVA FRUTESCENS L.[1]

Leaf thick, usually almost vertical, nearly isolateral.

Epidermis cells small, walls not undulate, thick, especially the outer; cuticle wrinkled, especially above and below the veins; stomata small, about equally numerous on both surfaces, the guard cells sunken, especially on the dorsal surface, lying irregularly in all directions; hairs on both surfaces (fig. 16) appressed, antrorse, thick-walled, 2 or 3 celled, sharp-pointed, the terminal cell abruptly narrowed just above its base, each hair borne upon 5 or 6 radially arranged foot cells which form a cushion that projects above the level of the epidermis; glands, 2 or 3 celled, sessile, nearly spherical, almost filling depressions in the epidermis and rising slightly above its general level.

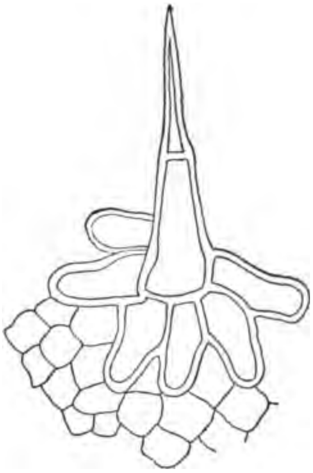

FIG. 16.– *Iva frutescens*—hair from ventral leaf surface. Scale 320.

Hypodermal collenchyma in strong groups above and below the larger veins (about 10 layers above and below the midvein).

Chlorenchyma palisadic, in several layers, the cells small and narrow, those near the midvein converging toward it; palisade frequently interrupted (especially opposite the mestome bundles) by a few rows of thin-walled, colorless parenchyma (water tissue), which ultimately breaks down into lacunes. Large ducts, each surrounded by a sheath of small cells, occur in the water tissue, especially on the ventral side of the leaf.

Mestome bundles with a little thin-walled stereome over the hadrome.[2]

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[1] The material examined was collected near Virginia Beach, Virginia.

[2] *Iva imbricata* Walt. is a common plant of the Atlantic sand strand in the Southeastern States, although not observed upon Ocracoke Island. It presents some interesting differences from the salt-marsh *I. frutescens*. The leaves examined were collected near Cape Henry, Virginia.

The plant is strongly aromatic, the leaf perfectly isolateral, fleshy and smooth.

Epidermis: cells much larger; cuticle not wrinkled; stomata with guard cells level with the ventral surface, somewhat sunken on the dorsal; hairs none.

Collenchyma less strongly developed than in *I. frutescens*.

Chlorenchyma consisting of 2 or 3 layers of palisade on both surfaces.

Colorless parenchyma (water-storage tissue), filling the interior of the leaf and interrupting the palisade above and below all the veins.

Mestome bundles lying in the midst of the water-storage tissue; stereome none.

The most important differences in *I. imbricata* are the strong development of

BORRICHIA FRUTESCENS (L.) DC.

Leaves (fig. 17) fleshy, almost vertical, imperfectly isolateral, the surface glistening, whitish, mealy looking, especially in young leaves.

Epidermis (fig. 17) with small, thin-walled cells, very many of which are extended by tangential division into commonly 2 to 4 celled, thin-walled, pointed, usually bent hairs (fig. 18),[1] the whole forming a very dense covering and giving the leaf its peculiar, glistening aspect; stomata only on the ventral surface, the guard cells slightly sunken.

Collenchyma (hypodermal) in several layers above and below the large mestome bundles (five in the midvein).

Chlorenchyma consisting of very compact palisade, 2-layered on both surfaces; pneumatic tissue none.

Colorless parenchyma (water-storage tissue) (fig. 17) occupying the interior of the leaf and forming rather more than one-half its thickness, at somewhat regular intervals displacing the palisade on the dorsal side and extending to the epidermis. Ducts (on the ventral side) frequent just beneath these extensions.

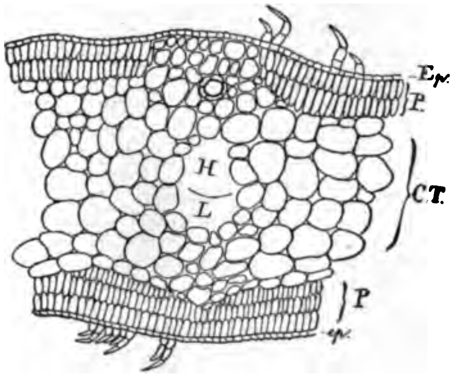

FIG. 17.—*Borrichia frutescens*—leaf section. Transverse section, showing epidermis of ventral surface (Ep); palisade (P); colorless parenchyma (C T); hadrome (H) and leptome (L) of a small mestome bundle; and epidermis of dorsal surface (ep). Scale 320.

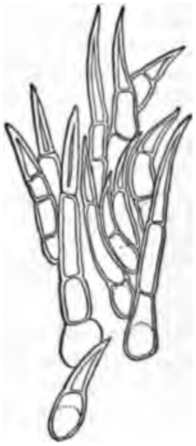

FIG. 18.—*Borrichia frutescens*—leaf-hairs. Scale 240.

Mestome bundles of the veins (fig. 17) lying deep in the water-storage tissue; reinforced on the leptome side by a strong group of very thick-walled stereome, on the hadrome side by a smaller group; leptome and its elements beautifully differentiated, the sieve tubes each with

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water-storage tissue in the interior of the leaf and the absence of hairs—just the converse of what one would expect as the differential characters between a dune and a salt-marsh species.

[1] The apical cells are easily broken off, so that in older leaves the covering appears to consist of rounded, usually bicellular papillae.

a companion cell and a band of four or five cribrile parenchyma cells.[1]

Leaf anatomy of salt-marsh species.

[The sign × indicates presence of character; ± its imperfect development.]

Species.	Leaf.				Epidermis.			
					Cuticle.			Radial walls undulate.
	Bifacial.	Isolateral.	Terete.	Relatively thick.	Thick.	Wrinkled.	Warty or granular.	
Triglochin striata		×		×	×		×	
Spartina stricta[1]								
Juncus roemerianus			×		×			
Sesuvium maritimum		×		×	×			
Tissa marina		×		×				×
Kosteletzkya virginica	×							
Ammania koehnei		±						×
Vincetoxicum palustre		±			×	×		
Lippia nodiflora	±				×	×		
Monniera monniera		×				×		×
Iva frutescens		×		×	×	×		
Solidago sempervirens		±		×	×	×		
Aster tenuifolius		×		×	×	×		
Aster subulatus		×			×	×		
Baccharis halimifolia		×		×	×		×	
Borrichia frutescens		±		×				

[1] Characters given under species of the "sand strand," page 33.

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[1] *Borrichia arborescens* (compare Warming, Halofyt-Studier, p. 212) is a very similar but larger plant of the tropical American strand. It differs from *B. frutescens* in the following particulars, the characters being taken from material collected in South Florida and Porto Rico:

Hairs much thicker-walled, entirely disappearing in old (more than 1 year old?) leaves; stomata on both surfaces, with guard cells slightly prominent on the ventral face, less numerous and with guard cells slightly sunken on the dorsal face; epidermal cell walls, especially the outer, thick; palisade interrupted both above and below by extensions of the water-storage tissue, which on the ventral side ultimately disorganize and form large lacunes; hypodermal collenchyma occurring where the palisade is interrupted on the ventral side; collenchyma taking the place of stereome as supports of the veins, especially strong on the leptome side.

From Warming's description and figure of *B. arborescens* my specimens showed important differences: (1) The presence of hairs (elsewhere in the same paper Warming mentions their occurrence in this species); (2) stomata with guard cells slightly prominent on the ventral surface (Warming writes "stomata sunken"); (3) collenchyma present and strongly developed; (4) mestome bundles in three planes (one according to Warming), some small ones being situated near the upper and the lower epidermis, while the midvein is central in the water-storage tissue.

Leaf anatomy of salt-marsh species—Continued.

[The sign × indicates presence of character; ± its imperfect development.]

Species.	Epidermis.								
	Stomata.								
	Both surfaces.	Ventral surface only.	Dorsal surface only.	Prominent.	Level with surface.	Sunken.	Parallel to leaf axis.	Irregularly disposed.	Subsidiary cells present.
Triglochin striata	×				×		×		×
Spartina stricta[1]									
Juncus roemerianus					×		×		
Sesuvium maritimum	×				×			×	
Tissa marina				×			×		
Kosteletzkya virginica	×			×					
Ammania koehnei	×			×			±		
Vincetoxicum palustre	×				×				
Lippia nodiflora	×					±		×	×
Monniera monniera	×				×				
Iva frutescens	×					×		×	
Solidago sempervirens	×				×				
Aster tenuifolius	×					×	±		
Aster subulatus	×				×		×		
Baccharis halimifolia	×			×			±		
Borrichia frutescens		×				±			

Species.	Epidermis.										Hypodermal collenchyma or collenchymatic tissue.	
	Hairs.											
	Both surfaces.	Ventral surface only.	Dorsal surface only.	Forming a dense covering.	Unicellular.	Pluricellular.	Simple.	Branching.	Stellate.	Glandular hairs or scales.	Only opposite veins.	Elsewhere.
Triglochin striata												
Spartina stricta[1]												
Juncus roemerianus												
Sesuvium maritimum												
Tissa marina						×	×			×		
Kosteletzkya virginica	×					×			×		×	
Ammania koehnei												
Vincetoxicum palustre												
Lippia nodiflora	×				×			×			×	
Monniera monniera												
Iva frutescens	×					×	×			×	×	
Solidago sempervirens											×	
Aster tenuifolius											×	
Aster subulatus												×
Baccharis halimifolia											×	
Borrichia frutescens	×			×		×	×				×	

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[1] Characters given under species of the "sand strand," page 29.

Leaf anatomy of salt-marsh species—Continued.

[The sign × indicates presence of character; ± its imperfect development.]

Species.	Stereome.			Chlorenchyma.					Water parenchyma.		Mestome bundles.	
	Subepidermal.	In leaf margins.	Adjoining mestome bundles.	Homogeneous.	Differentiated.	Palisade compact.	Palisade interrupted by water parenchyma.	Palisade converging toward midrib.	Filling the interior of the leaf.	Chiefly opposite the mestome bundles.	With mestome sheath.	With parenchyma sheath.
Triglochin striata	......	......	......	×	......	......	......	......	......	......	×	×
Spartina stricta[1]	......	......	......	......	......	......	......	......	......	......	......	......
Juncus roemerianus	×	......	×	×	......	×	......	......	......	......	×	×
Sesuvium maritimum	......	......	......	×	......	......	......	......	......	......	......	......
Tissa marina	......	......	......	×	......	......	......	......	×	......	......	......
Kosteletzkya virginica	......	......	×	......	×	×	......	......	......	......	......	......
Ammania koehnei	......	......	......	×	......	......	......	......	......	......	......	......
Vincetoxicum palustre	......	......	......	×	......	......	......	......	......	......	......	......
Lippia nodiflora	......	......	×	......	±	×	......	......	......	......	......	......
Monniera monniera	......	......	......	×	......	......	......	......	......	......	......	......
Iva frutescens	......	......	×	×	......	......	×	×	......	×	......	......
Solidago sempervirens	......	......	×	×	......	......	×	......	......	×	......	......
Aster tenuifolius	......	......	......	×	......	×	......	×	×	......	......	......
Aster subulatus	......	......	......	×	......	×	......	......	......	×	......	......
Baccharis halimifolia	......	......	×	×	......	......	......	×	......	×	......	......
Borrichia frutescens	......	......	×	×	......	×	×	......	×	......	......	......

[1] Characters given under species of the "sand strand," p. 29.

GEOGRAPHICAL AFFINITIES OF THE FLORA.

According to its geographic position, Ocracoke Island lies well within the Austroriparian area of the Lower Austral life zone in North America.[1] For two reasons, however, this relationship of its flora is somewhat obscured: (1) By the large proportion of strand species, many of which have a very extensive geographic range; and (2) by the absence of many of the most characteristic species of the Austroriparian area, due to the peculiar physical environment.

Of the total number of species of embryophytes (about 135) collected or observed upon Ocracoke Island, between one-fourth and one-third may be designated as maritime, i. e., normally occurring only in the salt marshes or on the sand strand bordering the ocean. These may be segregated into 4 groups, according to geographical range:

1. Species occurring also on the coasts of tropical America.

A prefixed asterisk (*) indicates that the species does not extend north of the mouth of Chesapeake Bay; a prefixed dagger (†) that the northern limit is in North Carolina, probably not far from Ocracoke. *Triglochin striata* and *Monniera monniera* extend north to eastern Maryland.

---

[1] Merriam, Geogr. Distrib. p. 211; Life Zones p. 45, map.

Triglochin striata R. & P.
**Quercus virginiana* L.[1]
†*Chloris petraea* Sw.
**Uniola paniculata* L.
**Fimbristylis spadicea* Vahl.
†*Yucca aloifolia* L.
**Physalis viscosa* L.
Monniera monniera H. B. K.
**Borrichia frutescens* L.
†*Ipomoea sagittata* Cav.

2. Species mostly or entirely confined to the seacoast of the Austroriparian area: *Zanthoxylum clava-herculis* and, possibly, *Ilex vomitoria* extend northward to Virginia, while the rest attain their northern limit in North Carolina.

Muhlenbergia filipes M. A. Curtis.
Yucca gloriosa L.
Croton maritimus Walt.
Zanthoxylum clava-herculis L.
Ilex vomitoria Ait.
Opuntia pes-corvi Le Conte.
Vincetoxicum palustre (Pursh) A. Gray.

3. Species confined to the Atlantic seacoast of North America and ranging north of the Austroriparian area. The northern limit of each is cited as given in Britton & Brown's Illustrated Flora.

Panicum amarum minus Vasey & Scribn. (Connecticut).
Spartina patens (Ait.) Muhl. (Nova Scotia).
Distichlis spicata (L.) Greene[2] (Maine).
Juncus roemerianus Scheele (New Jersey).
Sesuvium maritimum (Walt.) B. S. P. (New York).
Euphorbia polygonifolia L. (Rhode Island).
Kosteletzkya virginica L. (New York).
Ammania koehnei Britton (New Jersey).
Oenothera humifusa Nutt. (New Jersey).
Limonium carolinianum (Muhl.) Britton (Labrador).
Iva frutescens L. (Massachusetts).
Solidago sempervirens L. (New Brunswick).
Aster tenuifolius L. (Massachusetts).
Aster subulatus Michx. (New Hampshire).
Baccharis halimifolia L. (Massachusetts).

4. Species occurring also on the seacoast of the northern hemisphere in the Old World.

Spartina stricta (Ait.) Roth.
Atriplex hastata L.
Salicornia herbacea L.
Salsola kali L.
Tissa marina (L.) Britton.

Of the nonmaritime species of the island, fifteen are introduced and are chiefly weeds of American origin. The remainder (about two-thirds of the total flora) includes several mainly tropical species, such as *Lippia nodiflora* Michx., *Centella asiatica* (L.) Urban, *Parietaria debilis* Forst., and *Tillandsia usneoides* L., which, while hardly maritime, are found usually near the seacoast in the Austroriparian area. Finally, after excluding all the preceding categories except the second of strand plants, we have a list of species among which the Austroriparian element is sufficiently predominant to leave no question as to the general affinity of the flora.

As previously remarked, however, many of the plants most characteristic of the whole Austroriparian area, and abundant on the mainland, scarcely 30 kilometers distant, are wanting upon Ocracoke Island. Notable among these absentees are the pines (*Pinus palustris*, *P. taeda*), the gums (Nyssa spp.), the bald cypress (*Taxodium distichum*), the deciduous oaks, the cane (*Arundinaria macrosperma*), species of Erianthus, *Carex verrucosa*, *Smilax laurifolia*, and *Berchemia scandens*. Hardly less striking is the nonoccurrence of most of the bright-flowered herbs that abound in the pine forests on the west shore of Pamlico Sound. Such are species of Coreopsis, Helianthus, Lacinaria (Liatris), Eupatorium, Solidago, Rhexia, Gerardia, Hypericum, Sarracenia, Habenaria, and Polygala. The unfavorable environment is doubtless responsible for the absence of many of these plants, conditions upon the island being suitable only to the hardiest species. Scarcity of shade, of humus, and of fresh water accounts in like manner for the poverty of the flora in most of the lower forms, such as fresh-water algae, fungi, hepaticae, mosses, and ferns. The numerous arrangements by which many of the higher plants are protected against excessive loss of water may also serve in some measure for protection against parasitic leaf fungi, and may partly account for the comparative scarcity of the latter.

---

[1] Normally a strand plant in Virginia and North Carolina.

[2] The typical form.

The general aspect of the plant covering is not attractive. Bright green foliage and flowers of brilliant coloring are too scarce to make much impression, while, except in the salt marshes, the plants are usually so scattered that it is the soil which gives tone to the landscape. Furthermore, the trees and shrubs are mostly characterized by gnarled trunks, many dead branches, and ragged foliage, as a result of exposure to sand-laden winds. Altogether, the picture is one of somber monotony.

LIST OF PLANTS COLLECTED AND OBSERVED.

[The prefixed asterisk denotes that the plant is introduced.]

LICHENES.

Usnea barbata L.
Ramalina montagnei De Not.

MUSCI.

Bryum argenteum L.
Rhynchostegium serrulatum Hedw.

POLYPODIACEAE.

Asplenium platyneuron (L.) Oakes. (*A. ebeneum* Ait.)

PINACEAE.

Juniperus virginiana L.

TYPHACEAE.

Typha latifolia L.

SCHEUCHZERIACEAE.

Triglochin striata Ruiz & Pav.

POACEAE.

Andropogon glomeratus (Walt.) B. S. P. (*A. macrourus* Michx.)
Paspalum ciliatifolium Michx.
Paspalum distichum L.
Paspalum laeve Michx.
Syntherisma fimbriata (Smith) Nash. (*Digitaria fimbriata* Smith.)
Panicum amarum minus Vasey & Scribner.
Panicum lanuginosum Ell. (?)
Panicum laxiflorum Lam.
Panicum neuranthum Griseb.
Panicum walteri Pursh.
Oplismenus setarius (Lam.) Roem. & Schult.
Chaetochloa imberbis perennis (Hall) Scribn. & Merrill. (*C. versicolor* Bicknell.)
Homalocenchrus virginicus (Willd.) Britton. (*Leersia virginica* Willd.)
Muhlenbergia filipes M. A. Curtis.
**Sporobolus indicus* (L.) R. Br.
**Capriola dactylon* (L.) Kuntze. (*Cynodon dactylon* Pers.)
Spartina patens (Ait.) Muhl. (*S. juncea* Ell.)
Spartina stricta (Ait.) Roth.
Chloris petraea Sw.
**Eleusine indica* (L.) Gaertn.
Triplasis purpurea (Walt.) Chapm.
Eragrostis nitida (Ell.) Chapm.
Uniola laxa (L.) B. S. P. (*U. gracilis* Michx.)
Uniola paniculata L.
Distichlis spicata (L.) Greene. (*D. maritima* Raf.)

CYPERACEAE.

Cyperus cylindricus (Ell.) Britton. (*C. torreyi* Britton.)
Cyperus echinatus (Ell.) Wood. (*C. baldwinii* Torr.)
Cyperus nuttallii Eddy.
Cyperus speciosus Vahl.
Eleocharis sp.
Dichromena colorata (L.) A. S. Hitchcock. (*D. leucocephala* Michx.)
Fimbristylis spadicea (L.) Vahl.
Scirpus americanus Pers. (*S. pungens* Vahl.)
Scleria verticillata Muhl.
Cladium effusum Torr.

ARACEAE.

Acorus calamus L.

BROMELIACEAE.

Tillandsia usneoides L.

JUNCACEAE.

Juncus dichotomus Ell.
Juncus roemerianus Scheele.
Juncus scirpoides Lam.

LILIACEAE.

Yucca aloifolia L.
Yucca gloriosa L.

SMILACEAE.

Smilax bona-nox L. (*S. tamnoides* A. Gray.)

MYRICACEAE.

Myrica carolinensis Mill.
Myrica cerifera L.

FAGACEAE.

Quercus virginiana L. (*Q. virens* Ait.)

MORACEAE.

* *Ficus carica* L.
* *Broussonetia papyrifera* (L.) Vent.

URTICACEAE.

Parietaria debilis Forst.

POLYGONACEAE.

Polygonum punctatum Ell.
Rumex sp.

CHENOPODIACEAE.

* *Chenopodium anthelminticum* L.
Atriplex hastata L.
Salicornia herbacea L.
Salsola kali L.

PHYTOLACCACEAE.

Phytolacca decandra L.

AIZOACEAE.

Sesuvium maritimum (Walt.) B. S. P. (*S. pentandrum* Ell.)
Mollugo verticillata L.

ALSINACEAE.

Tissa marina (L.) Britton. (*Spergularia salina* J. & C. Presl.)

ROSACEAE.

Rubus trivialis Michx.

CAESALPINACEAE.

* *Cassia occidentalis* L.

VICIACEAE.

Aeschynomene virginica (L.) B. S. P. (*A. hispida* Willd.)
Meibomia paniculata (L.) Kuntze. (*Desmodium paniculatum* DC.)
Galactia volubilis (L.) Britton. (*G. pilosa* Ell.)

LINACEAE.

Linum medium (Planch.) Britton.

RUTACEAE.

Zanthoxylum clava-herculis L.

EUPHORBIACEAE.

Croton maritimus Walt.
Acalypha gracilens A. Gray.
Euphorbia polygonifolia L.

ANACARDIACEAE.

Rhus radicans L.

ILICACEAE.

Ilex glabra (L.) A. Gray.
Ilex opaca Ait.
Ilex vomitoria Ait. (*I. cassine* Walt.)

VITACEAE.

Vitis aestivalis Michx.

MALVACEAE.

Kosteletzkya virginica (L.) A. Gray.
Hibiscus moscheutos L.
* *Gossypium herbaceum* L.

HYPERICACEAE.

Ascyrum hypericoides L.

CISTACEAE.

Lechea villosa Ell. (*L. major* Michx.)

CACTACEAE.

Opuntia pes-corvi Le Conte.

LYTHRACEAE.

Ammania koehnei Britt.

ONAGRACEAE.

Ludwigia alata Ell.
Ludwigia microcarpa Michx.
Oenothera humifusa Nutt.

APIACEAE.

Sanicula sp.
Hydrocotyle umbellata L.
Centella asiatica (L.) Urban.

PRIMULACEAE.

Samolus floribundus H. B. K.

PLUMBAGINACEAE.

Limonium carolinianum (Walt.) Britton. (*Statice limonium* var. *carolinianum* A. Gray.)

LOGANIACEAE.

Cynoctonum mitreola (L.) Britton. (*Mitreola petiolata* Torr. & Gr.)
Polypremum procumbens L.

ASCLEPIADACEAE.

Vincetoxicum palustre (Pursh) A. Gray. (*Seutera maritima* Decne.)

CONVOLVULACEAE.

Ipomoea sagittata Cav.

VERBENACEAE.

Lippia nodiflora Michx.
Callicarpa americana L.

NEPETACEAE.

Teucrium nashii Kearney.
Monarda punctata L.

SOLANACEAE.

Physalis viscosa L.
Solanum carolinense L.
* *Solanum nigrum* L.
* *Lycopersicum esculentum* L.
* *Datura tatula* L.

SCROPHULARIACEAE.

* *Verbascum thapsus* L.
Monniera monniera (L.) Britton. (*Herpestis monniera* H. B. K.)
Gerardia maritima Raf.

RUBIACEAE.

Oldenlandia uniflora L. (*O. glomerata* Michx.)
Diodia teres Walt.
Diodia virginiana L.
Galium sp. (probably *G. tinctorium* L. or *G. claytoni* Michx.).

CUCURBITACEAE.

* *Citrullus vulgaris* Schrad.
Melothria pendula L.

CICHORIACEAE.

Hieracium gronovii L.

CARDUACEAE.

Elephantopus nudatus A. Gray.
Mikania scandens (L.) Willd.
Solidago sempervirens L.
Euthamia caroliniana (L.) Greene. (*Solidago tenuifolia* Pursh.)
Aster salicifolius Lam. var.
Aster subulatus Michx.
Aster tenuifolius L.
Erigeron canadensis L.
Baccharis halimifolia L.
Pluchea camphorata (L.) DC.
Pluchea foetida (L.) B. S. P. (*P. bifrons* DC.)
Gnaphalium purpureum L.
Ambrosia artemisiaefolia L.
Iva frutescens L.
Xanthium sp.
Xanthium sp.
Borrichia frutescens L.
* *Bidens bipinnata* L.
Erechtites hieracifolia (L.) Raf.
Carduus spinosissimus Walt. (*Cnicus horridulus* Pursh.)

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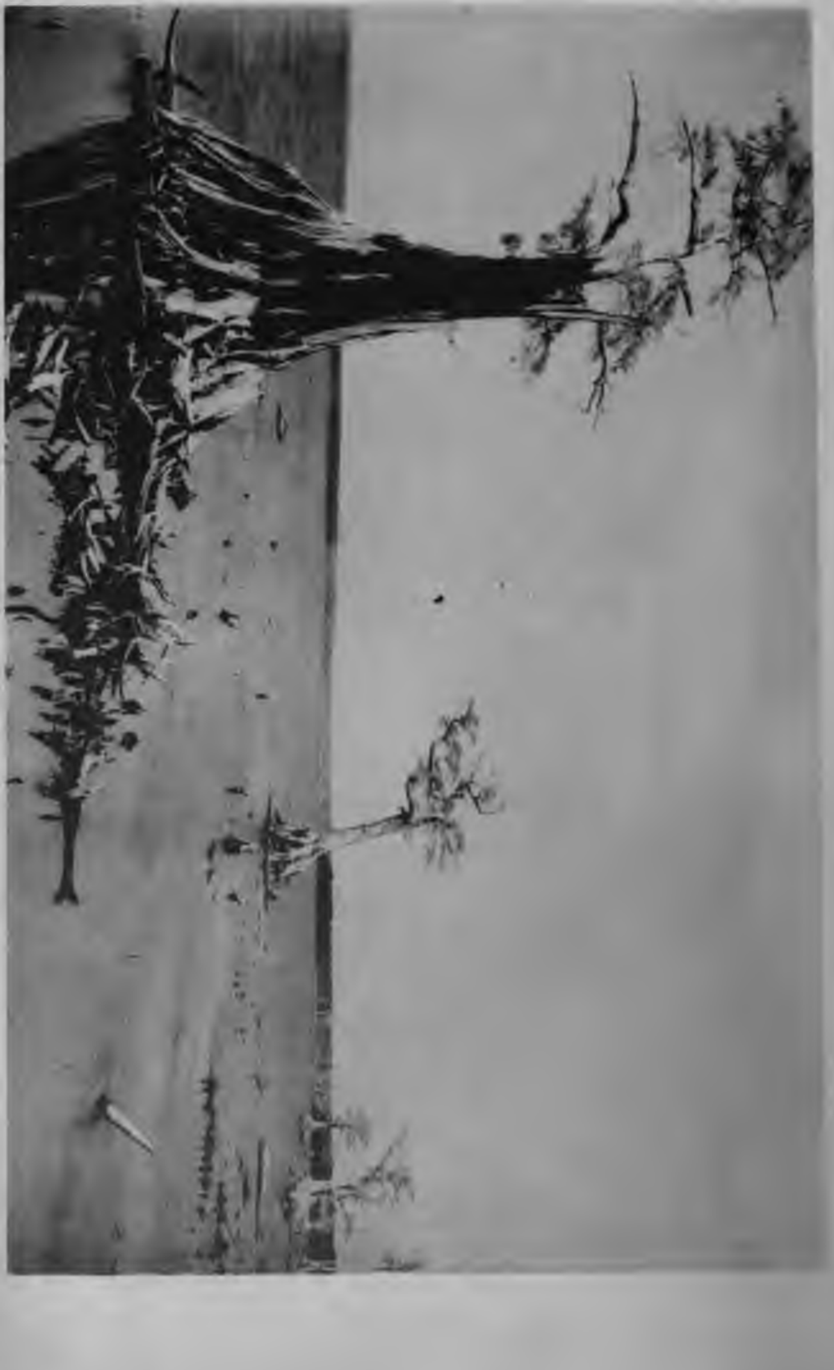

LAKE DRUMMOND, DISMAL SWAMP.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

CONTRIBUTIONS

FROM

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REPORT ON A BOTANICAL SURVEY OF THE DISMAL SWAMP REGION.

BY

THOMAS H. KEARNEY.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., June 10, 1901.

SIR: I have the honor to transmit herewith a manuscript entitled "Report on a Botanical Survey of the Dismal Swamp Region," prepared under my immediate direction by Mr. Thomas H. Kearney, formerly assistant botanist, and to recommend it for publication as Contributions from the U. S. National Herbarium, Vol. V, No. 6.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

Page.

Introduction 321
Climate 324
  Temperature 324
    Thermometrical record 324
    Latest and earliest frosts 326
  Sunshine and cloudiness 327
  Atmospheric humidity 328
  Precipitation 328
  Wind 330
  Summary 330
Geography and physiography 331
  General geography of the region 331
  Prominent physiographic features 332
    The beach and the dunes 332
    The salt marshes 337
    The plain 338
    The swamps 338
Geology 342
Soils 344
  The salt marshes 344
  The sand strand 344
  The plain—truck soils 345
    General observations 345
    Descriptions and analyses of samples 348
  The wooded swamps 349
    Organic matter 350
    Acidity 351
    Clay content 352
    Texture 353
    Water 355
    Drainage 355
    Soil analyses 358
The plant covering of the region: its physiognomy and ecology 358
  Formation classes 359
  Maritime formations 360
    Salt-marsh formations 360
    Adaptations to environment in the salt-marsh vegetation—life forms 364
    Sand-strand formations 367
      Beach and outer dunes 368
      Middle (open) dunes 370
      Inner (wooded) dunes 378
      Sand strand of Lynnhaven Bay 381

The plant covering of the region, etc.—Continued.

Page.
Maritime formations—Continued.
Adaptations to environment in the strand vegetation—life forms ... 382
Modifications due to the mechanical action of the wind ... 383
Protection against excessive transpiration ... 387
Protection against excessive light ... 393
Pollination ... 393
Dissemination of seeds ... 393
General aspects of the strand vegetation ... 394
Nonhygrophile inland formations ... 395
Forest formations ... 396
Mixed forest ... 396
Pine barrens ... 405
Cleared land formations—noncultural ... 406
Arboreous associations ... 406
Shrubby associations, thickets and hedges ... 407
Herbaceous associations ... 408
Cultural formations ... 410
Field crops ... 410
Cultivated trees ... 412
Weeds ... 413
Adaptations to environment in the nonhygrophile inland vegetation—life forms ... 415
Classification of lianas ... 416
Fresh-water formations ... 417
Hygrophile forest ... 417
Black-gum swamp ... 417
Open or light swamp ... 423
Adaptations to environment in the hygrophile forest—life forms ... 429
Adaptations to reduce transpiration ... 430
Aerating adaptations ... 433
Other ecological characters ... 434
Fresh-water marsh formations ... 436
Reed-marsh formation ... 436
Low-marsh formation ... 439
Adaptations to environment in the fresh-water marsh—life forms ... 440
Aquatic vegetation ... 443
Composition and physiognomy ... 444
Adaptations to environment ... 445
Phytogeographical affinities of the flora ... 447
Position in life zones of North America ... 448
Austroriparian plants reaching their northern limit in the Dismal Swamp region ... 448
Plants reaching their southern limit in the Dismal Swamp region ... 449
Northern limits of Austroriparian plants of the Dismal Swamp region ... 450
Relationship to other floras ... 458
Agricultural products ... 463
Truck crops ... 463
Cereals ... 467
Cotton ... 468
Forage plants ... 468
Peanuts ... 470
Fruits ... 470

Agricultural products—Continued.

Page.
Other crops 471
Agricultural weeds 471
Relation of the native plant growth to the character of the soil 473
Comparative influence of drainage and chemical factors 474
Types of arable soils 474
Native vegetation of truck lands 474
Vegetation of lands unsuited to truck farming 479
Illustrative quotations 481
Anatomical notes 484
List of the plants collected or observed 509
Bibliography 547

ILLUSTRATIONS.

PLATES.

Page.
PLATE LXV. Lake Drummond, Dismal Swamp ... Frontispiece.
LXVI. View near the headwaters of Northwest River, Dismal Swamp ... 332
LXVII. View in the Black Gum swamp ... 352
LXVIII. Cypress trees in Lake Drummond, bearing Spanish moss (*Tillandsia usneoides*) ... 420
LXIX. Black Gum swamp, showing knees of the cypress (Taxodium) and arched roots of the black gum (*Nyssa biflora*) ... 420
LXX. Poison ivy (*Rhus radicans*) in Black Gum swamp (on the right); cane (*Arundinaria macrosperma*) and *Osmunda regalis* (foreground) ... 422
LXXI. Big cane (*Arundinaria macrosperma*) along a ditch in Black Gum forest ... 422
LXXII. Association of shrubs and small trees along ditches in the "light swamp" ... 426
LXXIII. Cypress knees and black gums (*Nyssa biflora*) with swollen bases ... 434
LXXIV. The Dismal Swamp Canal near South Mills, N. C ... 440
LXXV. Feeder connecting the Dismal Swamp Canal with Lake Drummond ... 440
LXXVI. Horse-tooth corn on land cleared from the Dismal Swamp at Wallaceton, Va ... 464
LXXVII. Timothy meadow on land cleared from the Dismal Swamp at Wallaceton, Va ... 464

FIGURES.

FIG. 51. Inner slope of high dunes at Cape Henry, Va., showing advance on "The Desert" ... 333
52. Incursion of the sand on inland vegetation near Cape Henry, Va ... 334
53. Incursion of the sand on inland vegetation near Cape Henry, Va ... 335
54. "The Desert" from the high dunes at Cape Henry, Va ... 336
55. Terrace along the shore near Virginia Beach; sand above, clay below ... 337
56. Cypress stumps on the margin of Lake Drummond ... 340
57. Salt marsh covered with *Spartina stricta maritima* ... 361
58. *Spartina stricta maritima* ... 362
59. Marram grass (*Ammophila arenaria*) on the dunes near Cape Henry, Va ... 369
60. Sea oats (*Uniola paniculata*) on the dunes near Cape Henry, Va ... 369
61. *Iva imbricata* on the dunes near Cape Henry, Va ... 370
62. Meadow-like growth of Ammophila near Oceanview, Va ... 371
63. Ammophila with *Myrica carolinensis* at Cape Henry, Va ... 371

Page.
FIG. 64. Thicket of "myrtle" (*Myrica carolinensis*) on a dune at Cape Henry, Va ... 372
65. Live oak (*Quercus virginiana*) on the middle dunes near Oceanview, Va ... 373
66. *Pinus taeda* among the sand dunes near Oceanview, Va ... 374
67. *Panicum amarum* among the middle dunes near Cape Henry, Va ... 375
68. *Panicum amarum* among the dunes near Oceanview, Va ... 376
69. *Hudsonia tomentosa* on the dunes near Virginia Beach (*Pinus taeda* in background) ... 377
70. Strand pine woods at Oceanview, Va ... 380
71. Innermost dunes encroaching on the strand pine woods (of *Pinus taeda*) near Virginia Beach, Va ... 381
72. *Diodia teres* on the middle dunes near Oceanview, Va., illustrating the radiant form ... 385
73. *Pinus taeda* along the Dismal Swamp Canal ... 397
74. Sweet gum (*Liquidambar styraciflua*) near Norfolk, Va ... 398
75. Sweet gum (*Liquidambar styraciflua*) at Wallaceton, Va ... 399
76. *Eupatorium capillifolium* on roadside near Wallaceton, Va ... 409
77. *Erianthus contortus* along a ditch near Portsmouth, Va ... 410
78. Rattan (*Berchemia scandens*) climbing on trees in the Black Gum swamp ... 420
79. Mistletoe (*Phoradendron flavescens*) on a red maple ... 422
80. Forest of "juniper" (*Chamaecyparis thyoides*) on the margin of the Dismal Swamp ... 424
81. Trunk of "juniper" (*Chamaecyparis thyoides*) ... 425
82. Big cane (*Arundinaria macrosperma*) ... 427
83. *Erianthus saccharoides* on the eastern margin of the Dismal Swamp. 438
84. *Cyperus erythrorhizos* along the Dismal Swamp Canal ... 441
85. Mouth of main drainage ditch emptying into the Dismal Swamp Canal, Wallaceton, Va ... 481
86. *Smilax laurifolia*, leaf in cross section ... 488
87. *Hypericum pilosum*, leaf ... 496
88. *Lechea maritima*. Falsely bicellular hair from leaf ... 497
89. *Leucothoë axillaris*. Lower surface of leaf showing stomata ... 499
90. *Galium hispidulum*, leaf ... 507

MAPS.

MAP 1. Dismal Swamp district of Virginia and North Carolina ... 550
2. Norfolk Peninsula, showing fresh and salt water marshes, sand dunes, and uplands ... 550

REPORT ON A BOTANICAL SURVEY OF THE DISMAL SWAMP REGION.

INTRODUCTION.

During the summer of 1898 a botanical survey of the Great Dismal Swamp in southeastern Virginia, and of adjacent parts of Virginia and North Carolina, was carried on by this Division. From May to November a great part of the region as defined below was traversed and, as far as possible, carefully explored. The work was pursued in the extensive area bordered on the north by the mouth of Chesapeake Bay and on the south by the lower reaches of the Neuse River. But only that portion of it included in and immediately adjoining the Great Dismal Swamp, especially on the northeast, east, and southeast, could be surveyed with any considerable care in the time allotted.

During the prosecution of the survey headquarters were made in the city of Norfolk, and thence excursions were made into the surrounding territory. The Great Dismal Swamp was traversed in several directions, and that part which borders on Lake Drummond was somewhat thoroughly explored. The outer strand was carefully studied from Willoughby Spit, on the south shore of the Chesapeake, to a point about 8 miles below Virginia Beach, on the Atlantic, much time being given to Cape Henry and its vicinity. The "trucking" area in the neighborhood of Norfolk was frequently visited. In North Carolina the neighborhood of Elizabeth City, of Edenton, and especially of Newbern, was repeatedly traversed. A short time was spent upon Ocracoke Reef, a little south of Cape Hatteras, and the results there obtained were published in an earlier number of the Contributions from the United States National Herbarium.[1]

Two main objects were kept in view during the progress of the investigation, one of which was largely economic in its bearing, the other purely scientific. First, it was sought to ascertain in what degree the character of the native vegetation of the region, varying to a certain extent on different soils, may serve as an indication of the quality and value of the soil. Second, a study was made of the ecological distribution of the vegetation—in other words, of the various local assemblages in which the different species and forms are combined to form the plant covering of the region as a whole. As the character of the assemblage which occupies each limited tract is, of course, largely determined by conditions of the physical environment there prevailing, it is easily seen how closely related are these two lines of investigation. On its purely scientific side, the first is, indeed, merely an aspect of the second.

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[1] The Plant Covering of Ocracoke Island, Contr. Nat. Herb., vol. 5, No. 5 (1900).

The study of the native growth upon different soils presupposes some knowledge of the soils themselves. To supply this knowledge a special chapter upon the soils of the region has been contributed to the present report by Mr. Frank Gardner, through the kindness of Professor Whitney, of the Bureau of Soils. Mr. Gardner made a careful personal examination of the soils of the Dismal Swamp itself, and has also studied other soils in the neighboring territory. Two principal types of soil, the most valuable of the region, were especially considered in this part of the investigation—the light, sandy soils in the neighborhood of salt water, which are devoted to market gardening or "truck" growing, and the rich soils that have been reclaimed from the wooded swamps by felling the timber and by drainage, upon which the principal crops are corn and potatoes.

The principal agricultural products of the region are detailed and briefly described by way of preface to that section of the report which deals with the problem of the relation between soils and the native growth upon them. It was found that the solution of this problem presents considerable difficulty in the country investigated, owing to the lack of important chemical differences in the agricultural soils. Water content of the soil, depending largely upon the fineness of its particles and upon the drainage, was found to be the principal element in determining the character of the native growth. As this factor varies greatly within narrow limits, it soon became evident that it would be impossible to map the soils of the region by the forest growth upon them, as was originally intended. Yet it is believed that such positive results as were obtained will be useful in the further prosecution of this interesting and important but by no means simple line of investigation, and that even the negative results are not without value. Both contribute toward determining just how far a farmer may rely upon the quality of the native growth on his land as an indication of its value for this or that crop. It is hoped that the inquiry may be resumed in some region in which the natural conditions will admit of obtaining more definite results.

The purely scientific section of this report is largely devoted to a description of the several assemblages which make up the plant covering of the region as it actually occurs. To supplement the descriptions, which necessarily convey but a limited conception of the actual relations and appearance of the vegetation, numerous photographs are reproduced. A discussion of the character of the environment and the most striking modifications which apparently adapt plants thereto follows the description of each formation. Not only the gross adaptations, such as can be detected in the field with the unaided eye, but also peculiarities of minute structure which are to be regarded as fitting the plant to its surroundings, are here considered.

A more detailed description of the leaf anatomy of a number of the abundant or otherwise interesting species is presented in a succeeding chapter. Here the species are arranged in their systematic order, for convenience of reference. The anatomical descriptions are very far from being complete. In most cases merely the leaf is considered, and only those of its characters are mentioned which are believed to be directly related to the environment. A discussion of the broad geographical relationships of the flora of the Dismal Swamp region and a list of all species collected or noted complete the purely scientific portion.

As an indispensable preface to both the economic and the scientific sections, the first three chapters are devoted to the climate of the region, its geography and physiography, and its geology. Statistics of climate were obligingly communicated by the Chief of the United States Weather Bureau. Many of the data contained in the second chapter, and practically the whole of the third, were taken from manuscript of the text to the Norfolk folio of the Geological Atlas of the United States, to which access was had by the courtesy of the author, Mr. N. H. Darton, of the United States Geological Survey.

A list of all literature consulted in the preparation of the report is appended.

Of the photographs here reproduced, a considerable number were taken by the author. Others were made by Mr. Frederick V. Coville. A number of Dismal Swamp views were obtained from Mr. John G. Wallace, of Wallaceton, Va. Finally, an excellent series of photographs belonging to the Geological Society of America, several of which had previously been reproduced in Prof. N. S. Shaler's "General Account of the Fresh-Water Morasses of the United States," were kindly placed at our disposal by the Director of the United States Geological Survey. Professor Shaler's paper, a valuable contribution to knowledge of the geology, physiography, and vegetation of the region, was freely consulted and is often quoted in this report.

The author wishes to express his great indebtedness to the specialists to whom the determination of various groups is credited in the List of Species Collected. Mr. Theodor Holm, of Brookland, D. C., rendered valuable assistance in the preparation of the anatomical notes. Dr. E. L. Greene courteously extended the facilities of his valuable library. To Mr. C. D. Beadle, of the Biltmore Herbarium, Biltmore, N. C., I am indebted for data as to the northern limit of many Austroriparian plants. For various courtesies and much useful information I wish to express my obligations to the following gentlemen: Mr. T. R. Ballantyne and the late Maj. Charles Pickett, of Norfolk; Messrs. H. H. Kirn and J. T. Griffin, of West Norfolk; Mr. T. J. Barlow, of Portsmouth; Mr. Cannon, of the Albemarle and Chesapeake Canal Company; Mr. Wallace, of Wallaceton, Va., and Messrs. Willet, E. S. Meadows, and Cromwell, of Newbern, N. C.

CLIMATE.

The following data concerning the climate of the Dismal Swamp region have been communicated by the United States Weather Bureau.[1] Statistics are given from two stations in the region—Norfolk and Cape Henry, Va. The climate at Norfolk closely tallies with that of the Dismal Swamp itself, while at Cape Henry we find the more extreme meteorological conditions to which the strand vegetation of the region is exposed. In addition, data from the stations at Hatteras and at Wilmington, N. C., are presented. These points are considerably south of the Dismal Swamp region, but they are near enough to make a comparison of their climates with that of the more northern stations interesting and instructive.

TEMPERATURE.

THERMOMETRICAL RECORD.

The normal number of days per annum with a temperature above 6° C. (43° F.) is, at Norfolk, 295; at Hatteras, 365. During this period the normal sum total of daily temperatures above 6° C. (43° F.) is, at Norfolk, 3,359.4° C. (6,047° F.); at Hatteras, 3,749.4° C. (6,749° F.).[2]

The normal mean temperature of the six consecutive hottest weeks of the year is, at Norfolk, 26.3° C. (79.3° F.); at Hatteras, 25.9° C. (78.6° F.).[3]

Normal temperature.[4]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	4.6	6.0	8.3	13.4	19.1	23.9	25.8	24.8	21.7	15.9	10.2	6.0	15.0
	°F	40.4	42.8	46.9	56.2	66.4	75.1	78.5	76.6	71.1	60.6	50.3	42.8	59.0
Cape Henry	°C	4.5	6.6	7.3	12.6	18.0	22.8	25.0	24.7	22.1	16.5	11.0	6.6	14.8
	°F	40.2	43.9	45.2	54.6	64.5	73.1	77.0	76.4	71.8	61.8	51.9	43.9	58.7
Hatteras	°C	7.6	8.1	10.0	14.0	19.1	23.3	25.5	25.2	23.2	18.0	13.1	9.0	16.3
	°F	45.7	46.6	50.1	57.2	66.4	74.0	77.9	77.4	73.7	64.5	55.6	48.2	61.4
Wilmington	°C	8.3	9.9	12.2	16.4	20.9	24.8	26.5	25.7	23.1	17.5	12.6	9.0	17.2
	°F	46.9	49.8	53.9	61.5	69.7	76.7	79.7	78.2	73.6	63.5	54.6	48.2	63.0

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[1] For an account of the methods of computation and reduction employed by the Weather Bureau see Report of the Chief for 1891-92, p. 37; also for 1896-97, pp. 126, 127, and 279.

[2] The sum total of effective temperatures, as here defined, is the factor upon which Dr. Merriam bases the boreal limit of the transcontinental life zones in North America. See Nat. Geographic Mag., vol. 6, pp. 229 to 238 (1894), and Yearbook U. S. Dept. Agr. for 1894, pp. 211 to 218 (1895).

[3] The mean temperature of the six consecutive hottest weeks is the factor regarded by Dr. Merriam (loc. cit.) as most effective in determining the austral limit of species.

[4] All readings in these tables were taken in the shade.

Normal daily range of temperature.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	8.3	9.0	9.3	9.5	9.7	9.8	9.6	8.0	7.6	8.2	8.3	8.5	8.8
	°F	15.0	16.2	16.7	17.1	17.4	17.6	17.2	14.4	13.6	14.8	14.9	15.3	15.8
Cape Henry	°C	8.2	9.0	8.6	9.3	8.6	8.3	7.9	7.4	6.9	7.7	8.0	8.2	8.2
	°F	14.8	16.0	15.5	16.8	15.4	15.0	14.2	13.3	12.4	13.8	14.4	14.8	14.7
Hatteras	°C	7.0	7.1	7.2	6.9	6.4	5.7	5.5	5.1	5.3	5.7	6.3	7.1	6.3
	°F	12.7	12.8	12.9	12.5	11.5	10.3	10.0	9.2	9.6	10.2	11.3	12.8	11.3
Wilmington	°C	9.8	10.2	10.3	10.0	9.6	9.2	8.7	8.4	8.8	9.9	10.4	10.2	9.6
	°F	17.6	18.3	18.6	18.1	17.3	16.5	15.6	15.1	15.9	17.9	18.7	18.4	17.3

Absolute maxima.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	26.6	27.2	31.1	35.0	36.6	39.0	39.0	37.2	37.7	31.6	34.0	24.0	39.0
	°F	80.0	81.0	88.0	95.0	98.0	102.0	102.0	99.0	100.0	89.0	93.0	75.0	102.0
Cape Henry	°C	25.5	26.6	29.4	35.5	36.1	39.0	38.3	39.4	35.5	31.6	27.2	24.4	39.4
	°F	78.0	80.0	85.0	96.0	97.0	102.0	101.0	103.0	96.0	89.0	81.0	76.0	103.0
Hatteras	°C	26.1	22.8	29.4	30.0	34.0	39.0	37.2	36.1	35.0	32.2	26.1	22.8	39.0
	°F	79.0	73.0	85.0	86.0	93.0	102.0	99.0	97.0	95.0	90.0	79.0	73.0	102.0
Wilmington	°C	26.6	27.2	30.6	33.3	36.1	37.7	39.4	37.2	35.5	33.3	28.3	25.5	39.4
	°F	80.0	81.0	87.0	92.0	97.0	100.0	103.0	99.0	96.0	92.0	83.0	78.0	103.0

Mean maxima.[1]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	20.3	22.0	24.6	29.6	32.8	35.4	36.4	34.5	32.7	27.9	24.2	20.3	28.4
	°F	68.5	71.6	76.2	85.2	91.0	95.7	97.5	94.1	90.8	82.3	75.6	68.6	83.1
Cape Henry	°C	20.1	22.6	24.2	28.4	32.3	34.9	36.0	34.8	32.7	28.0	25.0	20.7	28.3
	°F	68.1	72.6	75.5	83.2	90.2	94.8	96.7	94.6	90.9	82.6	76.9	69.3	82.9
Hatteras	°C	19.2	20.4	20.6	23.4	27.4	30.7	31.0	30.7	29.7	26.6	23.6	20.2	25.2
	°F	66.6	66.8	69.0	74.1	81.4	87.2	87.9	87.3	85.5	80.0	74.5	68.4	77.4
Wilmington	°C	21.9	23.1	23.6	29.7	32.5	34.7	35.7	34.2	33.0	28.9	25.7	22.5	29.0
	°F	71.4	73.6	77.5	85.4	90.5	94.5	96.2	93.6	91.4	84.1	78.3	72.5	84.0

Absolute minima.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	−14.4	−16.6	−10.0	−4.4	3.3	9.4	13.9	13.3	4.4	−0.5	−6.6	−14.4	−16.6
	°F	6.0	2.0	14.0	24.0	38.0	49.0	57.0	56.0	40.0	31.0	20.0	6.0	2.0
Cape Henry	°C	−14.4	−15.0	−11.1	−2.2	5.0	8.8	13.3	10.6	9.4	1.7	−4.4	−13.9	−15.0
	°F	6.0	5.0	12.0	28.0	41.0	48.0	56.0	51.0	49.0	35.0	24.0	7.0	5.0
Hatteras	°C	−10.0	−11.7	−3.3	−0.5	6.1	12.8	16.1	16.6	10.0	5.5	−2.2	−13.3	−13.3
	°F	14.0	11.0	26.0	31.0	43.0	55.0	61.0	62.0	50.0	42.0	28.0	8.0	8.0
Wilmington	°C	−12.8	−12.2	−6.6	−2.2	3.3	10.6	15.5	13.3	5.5	0.0	−5	−12.2	−12.8
	°F	9.0	10.0	20.0	28.0	38.0	51.0	60.0	56.0	42.0	32.0	23.0	10.0	9.0

Mean minima.[2]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C	−7.9	−6.8	−3.7	1.8	7.7	13.8	17.1	17.1	12.1	5.2	−1.8	−6.8	4.0
	°F	17.8	19.7	25.4	35.2	46.0	56.8	62.8	62.8	53.8	41.4	28.8	19.7	39.2
Cape Henry	°C	−7.5	−6.4	−3.9	1.7	7.5	13.3	17.1	16.8	13.0	6.0	−1.1	−6.4	4.2
	°F	18.4	20.5	25.0	35.0	45.5	56.0	62.8	62.3	55.4	42.9	29.9	20.5	39.5
Hatteras	°C	−4.5	−3.3	−0.5	3.9	10.4	16.1	18.8	19.0	15.8	8.7	2.1	−3.2	6.9
	°F	23.9	26.0	31.0	39.1	50.8	61.0	65.6	66.4	60.4	47.7	35.8	26.3	44.5
Wilmington	°C	−6.2	−4.2	−1.7	3.3	8.7	14.6	18.1	16.9	12.0	4.8	−1.7	−5.5	4.9
	°F	20.8	24.4	29.0	37.9	47.7	58.3	64.6	62.5	53.7	40.7	29.0	22.0	40.9

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[1] Obtained for each month by dividing the sum of the absolute maxima during the period covered by observations by the number of years. The annual mean maximum for each station represents the mean of the monthly mean maxima. The years during which measurements of temperature have been taken at the several stations are: Norfolk, 1871 to 1898; Cape Henry, 1874 to 1898; Hatteras, 1881 to 1898; Wilmington, 1871 to 1898.

[2] Obtained in the same manner as the mean maxima.

LATEST AND EARLIEST FROSTS.

The dates of the latest killing frost in spring and the earliest in autumn are unquestionably an important factor in the life history of plants of the temperate zones, especially of cultivated plants. These two dates form the most easily recognizable, although not the precise limits of the growing period of most plants, or, to speak more exactly, of their period of greatest physiological activity.

The average dates of latest and earliest killing frosts at the four stations are:

Station.	Latest frost in spring.	Earliest frost in autumn.
Norfolk	Mar. 28	Nov. 14
Cape Henry	Mar. 19	Do.
Hatteras	Feb. 25	Dec. 13
Wilmington	Mar. 15	Nov. 12

The absolute dates of latest and earliest frosts during the period covered by observations are:

Station.	Latest frost in spring.	Earliest frost in autumn.
Norfolk	Apr. 26, 1888	Oct. 10, 1895
Cape Henry	Apr. 19, 1875	Nov. 11, 1894
Hatteras	Apr. 5, 1881	Nov. 14, 1890
Wilmington	Apr. 21, 1897	Oct. 13, 1888

The following table gives the actual dates of latest and of earliest killing frost of each year during the period of observation:

Year.	Norfolk.		Cape Henry.		Hatteras.		Wilmington.	
	Latest.	Earliest.	Latest.	Earliest.	Latest.	Earliest.	Latest.	Earliest.
1873		Nov. 14						Nov. 14
1874	Apr. 13	Nov. 30	Mar. 25	Nov. 30			Mar. 14	Dec. 1
1875	Apr. 19	Nov. 18	Apr. 19	do			Apr. 19	Nov. 12
1876	Mar. 23	Oct. 15	Mar. 22	Nov. 27			Mar. 4	Nov. 26
1877	Mar. 20	Nov. 30	Mar. 20	Nov. 30			Mar. 18	Nov. 12
1878	Mar. 21	Oct. 21	Mar. 25	Dec. 6			Feb. 19	Nov. 1
1879	Mar. 6	Nov. 3	Mar. 6	Nov. 20			Apr. 4	Nov. 3
1880	Apr. 12	Nov. 16	Mar. 25	Nov. 16			Feb. 16	Nov. 16
1881	Apr. 7	Nov. 17	Mar. 29	Nov. 25	Apr. 5		Mar. 8	Nov. 24
1882	Feb. 26	Nov. 15	Feb. 5	Nov. 30	Jan. 4	Nov. 26	Jan. 23	Nov. 20
1883	Mar. 23	Nov. 30	Mar. 25	Dec. 15	Mar. 23	Dec. 16	Mar. 23	Nov. 13
1884	Mar. 5	Nov. 21	Mar. 5	Dec. 18	Mar. 5	Dec. 19	Mar. 4	Oct. 24
1885	Apr. 11	Dec. 3	Feb. 24	Dec. 3	Feb. 21	Dec. 27	Mar. 24	Nov. 25
1886	Mar. 4	Nov. 8	Mar. 18	Nov. 14	Feb. 8	Dec. 2	Mar. 3	Nov. 8
1887	Apr. 20	Nov. 6			Jan. 13	Dec. 29	Feb. 28	Dec. 2
1888	Apr. 26	Nov. 28			Mar. 7	Dec. 14	Mar. 10	Oct. 13
1889	Mar. 12	Nov. 7		Nov. 29	Feb. 25		Feb. 25	Nov. 29
1890	Mar. 17	Nov. 1	Mar. 17	do	Mar. 16	Nov. 14	Apr. 20	Nov. 1
1891	Mar. 18	Nov. 18	Mar. 16	Nov. 19	Mar. 15	Nov. 30	Mar. 15	Oct. 29
1892	Mar. 22	Nov. 6	Mar. 22	Nov. 23	Mar. 19	Nov. 24	Apr. 16	Oct. 21
1893	Mar. 30	Nov. 16		Dec. 7	Jan. 26	Nov. 25	Mar. 20	Nov. 17
1894	Mar. 28	Nov. 6		Nov. 11	Mar. 28	Dec. 28	Mar. 31	Nov. 7
1895	Mar. 21	Oct. 10	Mar. 29	Nov. 21	Feb. 25	Nov. 22	Mar. 22	Nov. 21
1896	Apr. 4	Nov. 14	Mar. 24	Nov. 14	Mar. 14	Dec. 6	Apr. 5	Dec. 1
1897	Apr. 21	Nov. 19	Feb. 3	Nov. 24	Feb. 28	Dec. 24	Apr. 21	Nov. 13
1898	Apr. 6	Nov. 21	Mar. 6	Nov. 30	Feb. 2	Nov. 27	Apr. 8	Nov. 21

From these data we may gather the following general conclusions: The climate of the Dismal Swamp region is characterized by a mild winter, with normal positive temperatures of 4° to 6° C., and by a long and hot, but usually not extremely hot, summer. The normal daily variation in temperature is comparatively small. Even the normal annual range is only between 8° and 9° C., and the departure of the normal variation in any month of the year from that of any other month does not exceed about 2° C. The normal number of days in the year which have a temperature above 6° C. (43° F.), which is generally regarded as the minimum temperature for vegetative activity in most plants of the Temperate Zone, is, at Norfolk, about five-sixths of the whole. The sum total of temperatures above 6° C. during that period is for the latitude a considerable one, enough to permit the occurrence in the region of a number of tropical and subtropical forms and to place it in the warm temperate belt.[1] Likewise important as regulating the northward extension into this region of numerous warm temperate and tropical forms is the distribution of killing frosts, from which about eight months of the year are normally free.

SUNSHINE AND CLOUDINESS.[2]

Normal percentages of possible sunshine.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	46	45	49	52	52	52	52	49	53	58	53	52	51
Cape Henry	42	51	50	50	56	55	53	49	56	58	51	47	52
Hatteras	46	47	52	55	59	55	55	52	56	58	54	53	54
Wilmington	47	46	52	56	54	50	48	47	52	60	55	52	52

Normal hours of sunshine.[3]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	188.1	136.5	181.5	205.3	228.3	228.9	232.6	205.8	197.5	201.8	162.0	155.7	2,324.0
Cape Henry	129.8	154.7	185.8	197.4	245.8	242.1	237.1	205.8	208.6	201.7	155.9	140.7	2,305.4
Hatteras	144.7	143.7	193.4	216.0	256.2	238.9	243.1	216.9	208.3	203.0	167.4	160.6	2,392.2
Wilmington	149.6	141.3	193.4	219.3	233.6	215.8	211.0	195.4	193.3	210.5	173.7	160.0	2,296.9

Normal cloudiness.[4]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	5.4	5.5	5.1	4.8	4.8	4.8	4.8	5.1	4.7	4.2	4.7	4.8	4.9
Cape Henry	5.8	4.9	5.0	5.0	4.4	4.5	4.7	5.1	4.4	4.2	4.9	5.3	4.8
Hatteras	5.4	5.3	4.8	4.5	4.1	4.5	4.5	4.8	4.4	4.2	4.6	4.7	4.6
Wilmington	5.3	5.4	4.8	4.4	4.6	5.0	5.2	5.3	4.8	4.0	4.5	4.8	4.8

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[1] Schimper (Pflanzengeographie, p. 445) regards the line which divides the cold temperate from the warm temperate belt as approximately coinciding with the isotherm of +6° C. (43° F.) for the coldest month. In the Dismal Swamp region the normal temperature falls slightly below this point in January.

[2] "Data as to sunshine are derived from the statistics of normal cloudiness and must be considered merely as a first approximation to the actual values of normal sunshine for these stations. For comparative purposes they may be used without serious error."—Mr. A. J. Henry, Division Climate and Crops, U. S. Weather Bureau, in litt.

[3] Based upon the same data as the above table but expressed in hours.

[4] From the Report of the Weather Bureau for 1896-97, pp. 286 to 288. The data are "computed from monthly means based on tridaily observations, November, 1870, to June 30, 1888; thereafter, frequent personal observations. Scale 0 to 10."

It thus appears that the percentage of possible sunshine and number of hours of sunshine are high as compared with other parts of the Atlantic slope in North America, although generally considerably lower than those recorded for stations west of the Mississippi River.

ATMOSPHERIC HUMIDITY.

Normal humidity in percentages of saturation.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	76	72	68	68	71	71	72	76	77	75	73	74	73
Cape Henry	77	74	73	72	73	74	76	78	76	74	71	74	74
Hatteras	84	81	79	80	82	83	83	82	81	81	79	82	81
Wilmington	73	71	69	68	72	74	76	80	78	75	72	73	73

The quantity of atmospheric water normally present in the Dismal Swamp region is not notably greater nor smaller than that which prevails in other parts of the northern and middle Atlantic slope in the United States, although falling considerably below the normal percentages of the coast from Charleston, in South Carolina, to Galveston, in Texas (78 to 82 per cent). The high percentage at Cape Hatteras is due to a local cause, the proximity at that point of the warm Gulf Stream and the cold Arctic Current. On the other hand, the humidity is of course far greater than in the arid and semiarid regions of the Western States (42.9 per cent at Yuma, Ariz.; 46.2 per cent at Pueblo, Colo., etc.). The distribution during the year is remarkably uniform, varying only to an extent of 9 per cent between the month of least and that of greatest normal humidity.

PRECIPITATION.

Rain.—The rain-bearing storms of this region usually approach from the west. The character of the rainfall (as to intensity) varies at different seasons. The winter and spring rains are usually light and long continued, while the summer and fall rains are more often heavy and of short duration, hence of the torrential type.

Normal precipitation, chiefly rain.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	cm	9.57	9.62	11.47	10.17	10.7	10.57	14.8	15.27	11.40	9.67	7.75	9.17	130.2
	in	3.83	3.85	4.59	4.07	4.28	4.23	5.92	6.11	4.56	3.87	3.10	3.67	52.08
Cape Henry	cm	10.6	8.9	12.8	11.15	10.17	9.87	14.07	13.85	11.37	9.47	8.12	9.67	130.85
	in	4.24	3.56	5.13	4.46	4.07	3.95	5.63	5.54	4.55	3.77	3.57	3.87	52.34
Hatteras	cm	14.77	11.17	15.25	11.8	11.5	11.42	16.07	15.87	16.1	15.42	12.95	13.67	166.02
	in	5.91	4.47	6.10	4.72	4.60	4.57	6.43	6.35	6.44	6.17	5.18	5.47	66.41
Wilmington	cm	9.85	8.07	9.87	7.4	10.4	14.25	18.1	18.67	16.05	9.6	6.12	7.45	135.85
	in	3.94	3.23	3.95	2.96	4.16	5.70	7.24	7.47	6.42	3.84	2.45	2.98	54.34

Average number of rainy days.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	12.7	11.0	11.6	10.7	11.2	10.4	12.4	12.7	9.4	8.9	9.9	10.4	131.3
Cape Henry	11.9	9.8	12.6	11.6	11.8	10.5	10.6	10.7	7.7	7.8	9.8	10.2	125.0
Hatteras	15.9	10.2	11.9	8.4	10.0	9.6	10.2	10.2	13.7	7.5	6.7	9.5	123.8
Wilmington	12.8	10.2	11.1	9.3	9.9	11.2	12.6	14.4	9.9	8.0	8.3	11.1	128.8

Snow.—The precipitation of snow during the winter is normally very small, both in quantity and in the number of days upon which snow falls. The snowfall during the winters of 1895–96 and 1896–97 was as follows:

Examples of snowfall.

Station.	1895–96.	1896–97.
Norfolk	14.2 cm. (5.7 in.)	31.2 cm. (12.5 in.)
Cape Henry	9.0 cm. (3.6 in.)	28.0 cm. (11.2 in.)
Hatteras	None.	None.
Wilmington	30.2 cm. (12.1 in.)	None.

The number of days in the year ended December 31, 1896, upon which snow fell to a depth of 2.5 mm. (0.1 inch) or more, was at Norfolk, 5; at Cape Henry, 9; at Hatteras, 0; at Wilmington, 2.

Precipitation thus means chiefly rainfall in the Dismal Swamp region, where the normal fall of snow in winter is too small to be of any noteworthy importance to the vegetation. The normal annual quantity of precipitated water is large as compared with that of most other temperate regions, although it is considerably less than at Cape Hatteras. The average number of days with rainfall during the year is more than one-third of the whole. The distribution of precipitation throughout the year, like that of atmospheric humidity, is remarkable for its uniformity. The normal variation in rainfall between the month of greatest (July) and that of least (November) amounts to only 7 centimeters at Norfolk and about 5 at Cape Henry. The variation in number of days on which rain falls between the month with most and that with least is likewise slight, being about four days at Norfolk and five at Cape Henry.[1]

Dew.—No data regarding the amount of dew deposited could be obtained, nor is this factor of primary importance to vegetation in a region which possesses such an abundant and equally distributed atmospheric humidity and rainfall.

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[1] The Dismal Swamp region belongs to Schimper's "immerfeucht Gebiet" of the warm-temperate belt (Pflanzengeographie, p. 500), which is characterized by its rainfall being pretty equally distributed throughout the year. It is exceptional, however, in that its large forest trees (excepting Pinus and Chamaecyparis) are all deciduous. Most hygrophile forest in the division thus characterized by Schimper is evergreen.

WIND.

The normal wind direction in midsummer is almost exactly opposite to the normal direction in midwinter. In January the prevailing winds at Norfolk are from slightly west of north; at Hatteras from almost due north, and at Wilmington from considerably west of north. In July, on the other hand, the prevailing winds at Norfolk and at Wilmington are from somewhat west of south, and at Hatteras from almost exactly southwest.[1]

Average maximum velocity of the wind.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	ks	15.6	16.6	18.2	15.6	13.5	14.2	12.9	13.2	15.2	15.9	16.3	15.0	15.2
	mi	9.7	10.3	11.3	9.7	8.4	8.8	8.0	8.2	9.4	9.8	10.1	9.3	9.4
Cape Henry	ks	25.5	25.2	30.3	23.7	21.0	22.0	19.0	20.8	21.8	22.4	23.5	24.8	23.2
	mi	15.8	15.6	18.8	14.7	13.0	13.6	11.8	12.9	13.5	13.9	14.6	15.4	14.4
Hatteras	ks	25.0	24.5	25.2	24.2	20.1	21.3	18.5	19.7	17.3	18.4	19.8	24.0	21.4
	mi	15.5	15.2	15.6	15.0	12.5	13.2	11.5	12.2	10.7	11.4	12.3	14.9	13.3
Wilmington	ks	15.5	16.6	18.2	18.7	16.9	15.6	14.7	13.5	14.2	13.7	14.2	13.7	15.5
	mi	9.6	10.3	11.3	11.6	10.5	9.7	9.1	8.4	8.8	8.5	8.8	8.5	9.6

The rate of movement of currents of air is of great importance to vegetation, not only by reason of their direct mechanical effect upon the plant and upon its substratum, but also because transpiration increases with the velocity of the wind, other things being equal. The average maximum velocity of the wind varies greatly within the limits of the Dismal Swamp region, the ratio of velocity at Cape Henry, one of the most exposed points on the Atlantic coast of North America, to that at Norfolk being nearly as 5 to 3. The range in average maximum velocity from month to month does not greatly vary, as that in the month of greatest (March) exceeds that in the month of least (July) by about 30 per cent.

SUMMARY.

The climate of the Dismal Swamp region as a whole is highly favorable in all essential respects to the vigorous growth of what we may term, for the sake of convenience, "normal" plants; i. e., such as are not especially equipped to endure any kind of extreme conditions. It is characterized by a long growing period with a relatively high sum total of effective temperature, a mild winter, normally slight daily variations of temperature, abundant sunshine, heavy and well distributed rainfall, and a high and remarkably uniform percentage of atmospheric moisture. It is preeminently a forest climate, and the whole region was, in its primitive condition, densely forested. There still remain, especially in the depths of the Dismal Swamp, many trees of great size. On the outer coast, however, among the sand dunes, local qualities of the soil and extreme exposure to the wind neutralize these favorable conditions and occasion the presence of vegetation which is decidedly desert-like.

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[1] See Rep. Chief U. S. Weather Bureau for 1896-97, charts 1 and 3.

GEOGRAPHY AND PHYSIOGRAPHY.

GENERAL GEOGRAPHY OF THE REGION.

The territory embraced in this report under the designation "Dismal Swamp Region" lies, roughly, between parallels 36° and 37° N. latitude and meridians 75° 50′ and 76° 35′ W. longitude. It covers a considerable part of the Coastal Plain[1] area in southeastern Virginia and northeastern North Carolina. It is bounded on the north by the mouth of the James River (Hampton Roads) and of Chesapeake Bay, on the east by the Atlantic Ocean, on the south by Albemarle Sound, and on the west approximately by the western border of the Great Dismal Swamp. The region, therefore, comprises the whole of Princess Anne and Norfolk counties and the eastern portion of Nansemond County in Virginia and the whole of Currituck, Camden, Pasquotank, and Perquimans counties in North Carolina.

Owing to the limited time which could be devoted to the survey, not every part of the area thus defined was thoroughly explored. The southern or North Carolina portion was only superficially and partially examined, the counties of Currituck and Camden having been traversed merely by railway. On the other hand, a large part of Princess Anne and Norfolk counties, Va., as well as of that section of Nansemond County which lies within the borders of the Dismal Swamp, was explored with considerable care.

The greatest length of the region, from Willoughby Spit south to Albemarle Sound, is nearly 96.5 kilometers (60 miles). Its greatest width, along the Virginia-North Carolina boundary, is about 65 kilometers (40 miles). Approximately the area embraces 6,200 square kilometers (2,400 square miles).[2] The whole is a flat or slightly undulating plain, varying in elevation from mean tide level to 6.6 meters (22.2 feet) above that level, except at some points along the outer coast, where the drifting sands form dunes that rise to a considerably greater height. The elevation of by far the greater part of the area is from 3 to 6 meters (10 to 20 feet). The maximum altitude, leaving out of consideration the sea dunes, is reached in the heart of the Dismal Swamp, from which point there is a gentle terrace-like slope toward sea level on the north, east, and south. Along the western margin of the great swamp occurs a more or less sharply defined ancient sea beach, the Nansemond escarpment, which varies in height from 1½ to 15 meters (5 to 50 feet)[1] and constitutes the natural western boundary of the Dismal Swamp region.

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[1] In order that the term "Coastal Plain," as here employed, may be perfectly clear to readers, I may be allowed to quote from Mr. N. H. Darton's manuscript the following definition:

"The central and southern portions of the Atlantic slope of the United States embrace four provinces of very distinct characteristics. From the westward there is, first, the plateau province, which comprises broad basins, occupied by upper Paleozoic rocks. The second is the Appalachian province, consisting of high, longitudinal ridges, due in greater part to sharply folded middle and lower Paleozoic rocks. Third, the Piedmont Plateau province, a region of undulating plains, extending from the Blue Ridge with a gradual declivity eastward, and underlain by crystalline rocks. And, fourth, the Coastal Plain, a province bordering the ocean, deeply invaded by tide-water estuaries and underlain by gently east-dipping unconsolidated strata from early Cretaceous to Recent age."

[2] This figure would be considerably smaller if we subtract the area of the numerous salt-water bays and lagoons which extend inland, especially on the north and east.

Numerous waterways traverse this flat plain, most of which have their source in or near the Dismal Swamp, and flow northward into the James River and Chesapeake Bay and southward and southeastward into Currituck and Albemarle sounds. These are the Nansemond and its tributaries, Elizabeth River and its branches, and Lynnhaven River with its numerous ramifications on the northwest, north, and northeast, and North Landing, Northwest, North, Pasquotank, Little, and Perquimans rivers on the east, southeast, and south. Near their sources most of these water courses are small fresh streams of sluggish, dark-brown water, rich in finely divided organic matter, but they soon widen out into estuarine channels in which tidal action is distinctly perceptible, and whose waters, in the streams flowing into the James and Chesapeake Bay, become first brackish and then salt. The brooks which are tributary to these rivers are in most cases more or less overgrown with palustrine vegetation and their current is usually almost imperceptible.

PROMINENT PHYSIOGRAPHIC FEATURES.

The principal physiographic features of the nonaqueous surface of the region are more or less intimately connected with and dependent upon the character of the plant formations which cover them, although this, in turn, is of course primarily due to conditions of soil and of drainage. The several areas which may be described in some detail, proceeding from the coast line toward the interior, are: (1) The beach and the dunes, (2) the salt marsh, (3) the plain, (4) the swamps.

THE BEACH AND THE DUNES.

This area follows the shore from the mouth of the Nansemond River around Cape Henry and down the outer Atlantic coast, as well as part way around the deep, irregular indentations of the shore line which are formed by Elizabeth and Lynnhaven rivers and their

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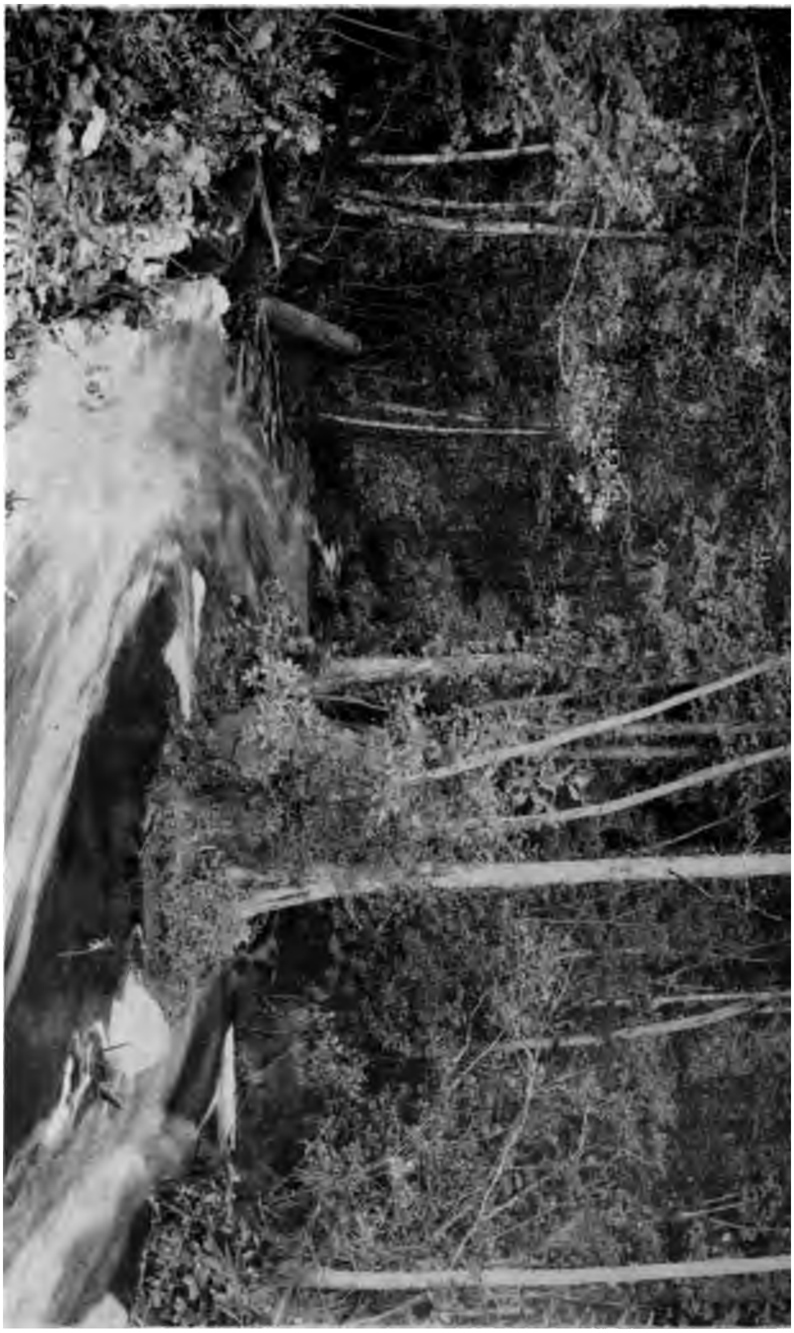
[1] Shaler, 10th Ann. Rep. Geol. Surv., pp. 255 to 339 (1890).



VIEW ON THE HEADWATERS OF NORTHWEST RIVER, DISMAL SWAMP.

THE HELIOTYPE PRINTING CO., BOSTON.

branches. It varies in width from a mere strip 2 or 3 meters wide (as along the estuaries) to nearly 1 kilometer (over ½ mile) at Cape Henry. Its surface everywhere consists of finely divided, wave-deposited, and often wind-blown whitish sand.

In the more sheltered coves and along the rivers and bayous the beach is ordinarily smooth and gently sloping, with a contour unbroken by abrupt elevations. The sands of the more exposed portions of the coast, on the other hand, are piled up by the wind so as to form dunes which are sometimes much the highest land of the region.

FIG. 51.—Inner slope of high dunes at Cape Henry, Va., showing advance on The Desert.

This area of sand hills reaches its culmination at Cape Henry, where the summit of the highest dune is roughly estimated to be 25 meters (80 feet) above mean tide level.[1] Thence along the south shore of Chesapeake Bay west to Willoughby Spit and along the Atlantic strand to a point 24 kilometers (15 miles) southeast of Cape Henry the dunes gradually decrease in size and finally disappear. Whether sand hills of any size occur between the Virginia-North Carolina boundary and Cape Hatteras was not ascertained.

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[1] The highest contour noted on the Norfolk folio of the Geological Atlas of the United States is 50 feet, but higher contours lying inside this are indicated. A century ago B. H. Latrobe (see below) estimated the height of the highest dune to be not "less than 100 feet above high-water mark."

The lesser dunes on this coast appear usually to originate about tufts of marram grass (*Ammophila arenaria*), although *Uniola paniculata*, *Panicum amarum*, and other plants are likewise effective as the nuclei of accumulations. As a rule the outermost dunes are the lowest, being only breast high or lower. The height of the hills increases with greater or less regularity to the innermost, normally the highest, line of dunes. The last are often forested, although at Cape Henry, where they attain their maximum elevation, they are devoid of vegetation excepting a few plants of marram grass (*Ammophila arenaria*). The outermost and innermost dunes usually form regular chains, broken here and there by the wind, but conforming mainly to the contour of the coast. The middle dunes also exhibit a tendency to form rows parallel to the shore line, but this tendency is often modified and obscured so that there frequently appears a total lack of order in their arrangement. The outer or seaward slope of the dunes is very gentle, and is usually more irregular than the abrupt landward declivity, whose angle, e. g., in the highest dunes at Cape Henry, is about 45 degrees.

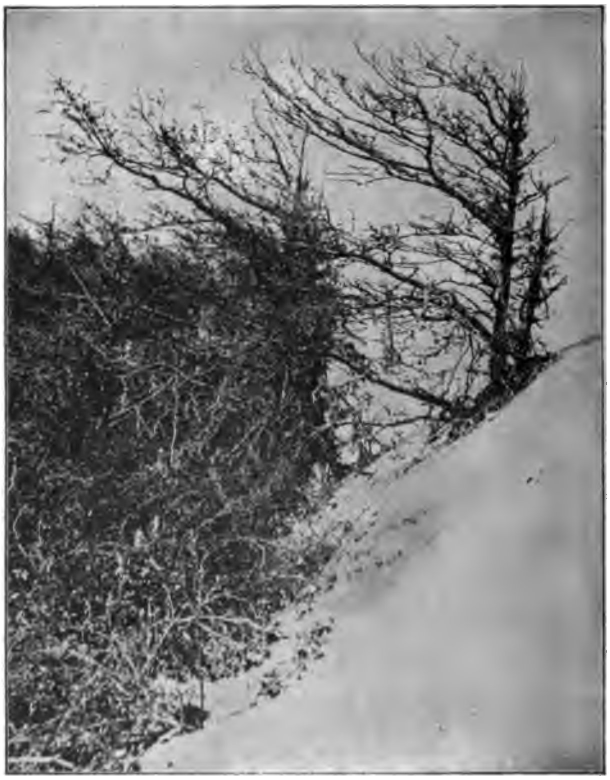

FIG. 52. Incursion of the sand on inland vegetation near Cape Henry, Va.

At and near Cape Henry the dune area is unmistakably advancing inland, while elsewhere along this coast such a movement is less evident or not to be detected (fig. 51). From the summit and the steep inward face of the highest dunes at Cape Henry project the tops of old cypress trees, some of which still bear a few living leaves (fig. 52). The sand is pouring down upon the floor of a tract of swampy forest (locally known as "The Desert,") and the leaves and branches of many of the trees have been more or less perfectly denuded by sand-laden winds (fig. 53). Between these high inner dunes and the beach are to be seen dead trunks of large pine trees standing amid the barren sands.

The Desert itself occupies an ancient dune area, and bears witness to the fact that, while at present the aeolian sands are gaining upon the forest, in times past a contrary process has had place (fig. 54). This forest area covers an area of alternate elevations and depressions, the former bearing a growth of oaks, pines, and a more or less xerophilous undergrowth, the latter a palustrine forest of cypress (Taxodium), black gum (*Nyssa biflora*), red maple (*Acer rubrum*), etc., with here and there small, shallow pools containing aquatic vegetation. The ridges which traverse The Desert conform generally in direction to that of the present coast line.

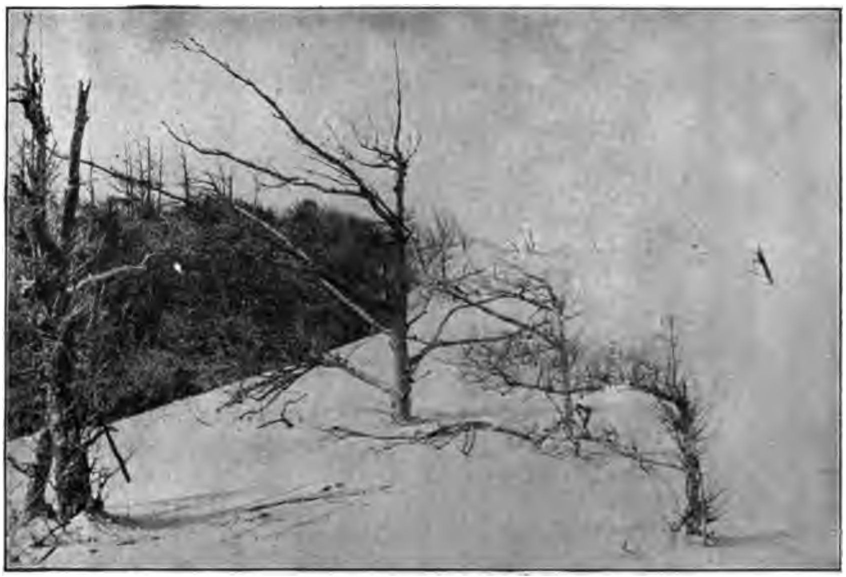

FIG. 53.—Incursion of the sand on inland vegetation near Cape Henry, Va.

Very interesting, as showing how little conditions have altered at Cape Henry within the past one hundred years, is the following description of the dunes as they appeared about 1799 to B. H. Latrobe:[1]

These easterly winds, blowing during the driest and hottest season of the year, carry forward the greatest quantity of sand, and have amassed hills, which now extend about a mile from the beach. The natural level of the land, elevated little more than 10 feet above high-water mark, has a very gentle declivity to the east. It is now a swamp of about 5 miles square (25 square miles). The soil below the surface is a white, loamy sand; and if the water falling upon or rising in it had a free discharge to the ocean it would probably be perfectly dry. This, however, the sand hills prevent, and the water is discharged into the sea to the southward and into the mouth of the Chesapeake to the northward by small creeks, which find vent from the westerly extremes of the swamp. Lynnhaven Creek is the most considerable of these drains. The swamp, or, as the neighboring inhabitants call it, The Desert, is overgrown with aquatic trees and shrubs. The gum (*L. styraciflua*), the cypress, the maple (*A. rubrum*), the tree improperly called "sycamore" (*Platanus occidentalis*), the *Magnolia virginiana*, the wax myrtle (*Myrica cerifera*), and the reed (*Arundinaria tecta*) are the principal. Of these many thousands are already buried in the sand, which overtops their summits and threatens the whole forest with ruin. Their destruction is slow, but inevitable. Upon the extreme edge of the sand hills, toward the swamp, the wind, opposed by the tops of the trees, forms an eddy. The sand carried along with it is precipitated, and runs down the bank into the swamp. Its slope is very accurately in an angle of 45 degrees. By gradual accumulation the hill climbs up their trunks; they wither slowly, and before they are entirely buried they die. Most of them lose all their branches, and nothing but the trunk remains to be covered with sand; but some of the cypress retain life to the last. * * *

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[1] Trans. Am. Phil. Soc., vol. 4, pp. 439 to 443 (1799).

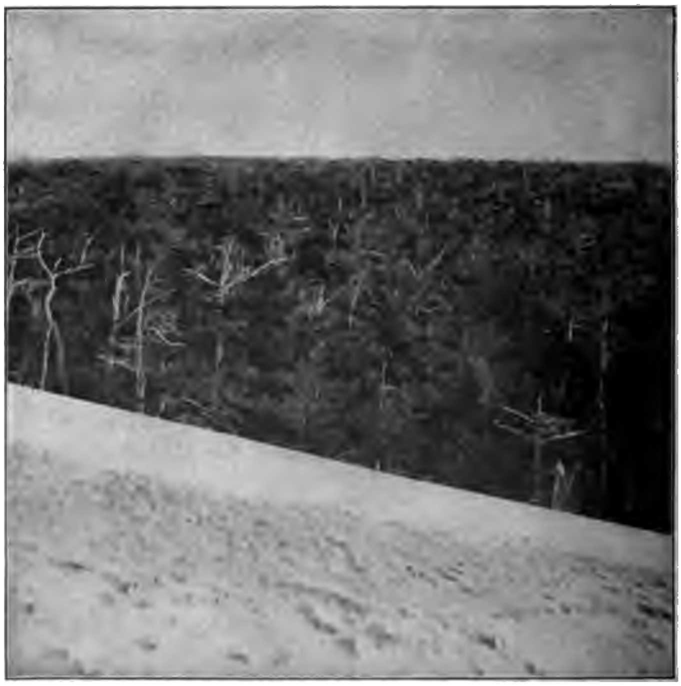

FIG. 54. -The Desert from the high dunes at Cape Henry, Va.

Since the establishment of the light (about sixteen years ago) the hills have risen about 20 feet in height, and have proceeded into the Desert about 330 yards from a spot pointed out to me by the keeper. * * * The height of the hill at the

> swamp is between 70 and 80 feet perpendicular. It is higher nearer the sea, the inner edge being rounded off, and I think at its highest point it can not be less than 100 feet above high-water mark.
>
> If the hills advance at an equal ratio for twenty or thirty years more, they will swallow up the whole swamp and render the coast a desert indeed, for not a blade of grass finds nutriment upon the sand [sic].

This is even to-day a very good picture of the Cape Henry sand hills and the forest behind them. The advance of the sand must have proceeded at a much less rapid rate during the past century, however, than during the sixteen years before Latrobe's visit.

Other evidences are not lacking of a subsidence and consequent recession of this coast line. In the low terrace of Columbia clay (fig. 55) which outcrops along the beach from Cape Henry southward, sometimes several meters above high-tide limit, sometimes between the levels of high and low tide, stumps *in situ* (usually of the cypress) are frequently to be seen. Such stumps are said to be abundant beneath the waters of Albemarle Sound.

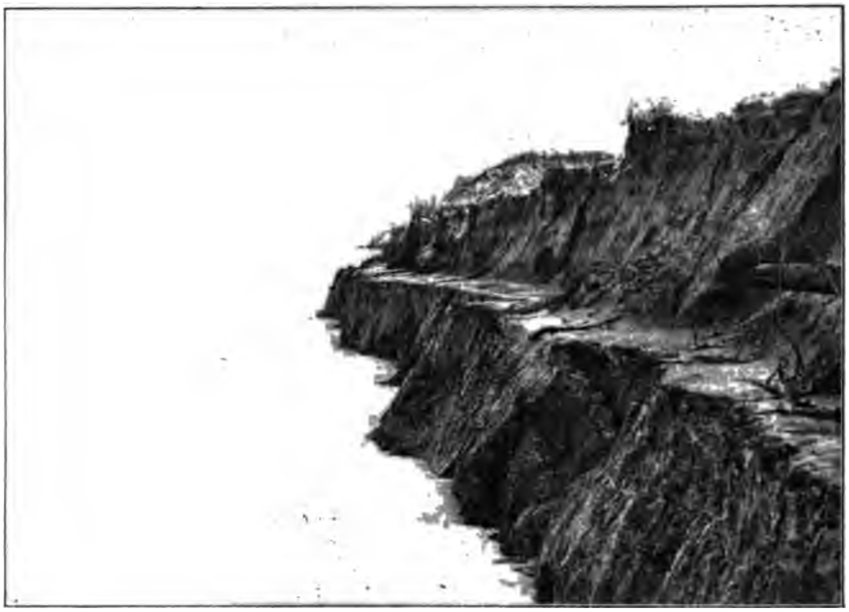

FIG. 55.—Terrace along the shore near Virginia Beach; sand above, clay below.

THE SALT MARSHES.

This topographical feature, which exactly coincides with a plant formation, is almost everywhere developed along creeks and rivers as far upstream as the influence of brackish water makes itself felt, and in sheltered bayous and lagoons where the slope of the shore is very gentle. Along streams the salt marsh consists usually of a narrow strip on each side of the channel, while in lagoons (notably the upper part of Back Bay) it sometimes takes the form of a meadow of considerable width. While the largest salt marshes are found just inside the beach and dune area of the outer coast, the narrow belts which fringe tidal streams penetrate deeply into the inland plain, where they are always at once recognizable by their peculiar vegetation.

The presence and extent of salt marshes along the shores of Currituck and Albemarle sounds was not ascertained. At the head of Back Bay, which eventually opens into Currituck Sound, extensive brackish meadows occur. On the other hand, this formation does not exist about Edenton Bay, on the north shore of Albemarle Sound. The latter sound, fed as it is by numerous fresh-water streams, some of which are of considerable size, is rarely at all brackish.

Above the limit of saline water the larger streams are bordered by marshes which resemble the salt marsh, but are occupied by fresh-water vegetation.

THE PLAIN.

The greater part of the territory east and north of the Great Dismal Swamp, together with that south of the swamp and immediately bordering Albemarle Sound, constitutes what may be termed "The plain." It was in all probability originally everywhere covered by a forest of short-leaf pine (*Pinus taeda*), in which hard-wood species (oaks, sweet gum, etc.) held a secondary place. Since the settlement of the region, however, conditions have been greatly altered. Much of it has been deforested and occupied by cultivated crops and by dwellings. In the remaining forest much of the pine has been cut down, and as a result deciduous species play a much more important part in its composition than was probably the case before the advent of civilization. Even then the pine forest was interrupted, especially along water courses, by areas of wooded swamp and of salt marsh. To-day it is for the most part broken up into scattered tracts of comparatively small extent, between which intervene areas of cleared land.

The general surface of this plain is flat or slightly undulating. Elevations that can be termed hills do not occur. To the drainage system and the differences in the plant covering, rather than the orography, is attributable what little of variety its physiognomy exhibits.

THE SWAMPS.

The Great Dismal Swamp and the lesser outlying morasses of the region constitute the most northeastern extensive outpost of that immense body of palustrine forest which covers so large a part of the Coastal Plain of the southeastern United States, and which extends up the Mississippi River and its larger tributaries to southeastern Missouri and southern Illinois and Indiana.

"The Dismal Swamp," to quote Professor Shaler, "belongs altogether to that group of inundated lands where the lack of drainage is due to an original deficiency of slope, combined with the flow-retarding influence of vegetation on the movement of water from the land."[1] North of the mouth of the Chesapeake the inclination of the plain is usually sufficiently great to permit the ready off-flow of the rainfall, while the climate is unfavorable to the development of certain types of vegetation (especially the large cane, *Arundinaria macrosperma*), that are particularly effective in retaining the surface water.

The total area of the Dismal Swamp is estimated at about 3,900 square kilometers (1,500 square miles), which comprises all extensive bodies of hygrophile forest lying between Elizabeth River and the mouth of the James on the north, and Albermarle Sound on the south. More than one-half of this area lies in North Carolina, the Virginia State line passing not far south of Lake Drummond. An additional 1,800 square kilometers (700 square miles) is computed to have been reclaimed by drainage from the original area of the great swamp. A large part of this land was deprived of its excess of water by the digging of the Dismal Swamp Canal, close upon a century ago. The canal traverses the swamp east of its center, and has had the effect of partially draining the region east of it, while retaining in the portion to the west much water that formerly escaped into the sounds. Consequently the western section of the swamp is probably wetter than it was a hundred years ago. Much of the land east of the canal is now in cultivation or is susceptible of cultivation after much less preparation than the western part of the swamp would require.

The outlines of the morass are very irregular, particularly on its eastern margin, where the reclamation of extensive tracts has cut off from the principal swamp some areas of hygrophile forest, especially along the upper waters of the rivers, which were once continuous with it. Occupying scattered depressions over the whole region, beyond what could ever have been the limits of the Great Dismal Swamp itself, are lesser tracts of similar character, which exhibit the same peculiarities, but on a smaller scale.

The Dismal Swamp is traversed by contour lines of from 1½ to 6 meters (5 to 20 feet) elevation, and a great part of its area is thus more elevated than the major portion of the plain lying to the east and northeast. The surface of Lake Drummond, nearly if not quite the highest point in the swamp, is normally 6¾ meters (22.2 feet) above sea level.

This interesting body of water (Pl. LXV, frontispiece), lying approximately in the center of the Dismal Swamp, is about 5 kilometers (3 miles) in greatest diameter, and is of quite regular shape, as the shore line forms long curves uninterrupted by promontories, and there are no islands. The depth of water, which is said not to have exceeded 2 meters (about 6 feet) in any portion originally, has been increased by the digging of canals and other artificial causes until the normal greatest depth is about 4½ meters (15 feet). In November, 1898, however, the depth was considerably less than 2 meters (6 feet) in almost every part of the lake, much of the water having been recently drained off through the feeder of the Dismal Swamp Canal. The water was then lower than it had ever before been known to be.

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[1] Shaler, loc. cit., p. 313.

The water of Lake Drummond, like that of the wooded swamps of the Coastal Plain generally, is of a deep brown hue and is rather turbid. When taken up in small quantity the color is much like that of sherry. This brown color is doubtless due to the great amount of finely divided vegetable matter with which it is impregnated. The people of the countryside ascribe to the swamp water tonic properties, which they believe to be derived from the bark and wood of the "juniper," or white cedar. Despite this large percentage of organic matter held suspended in its water, the floor of the lake is in large part covered with a fine white sand.

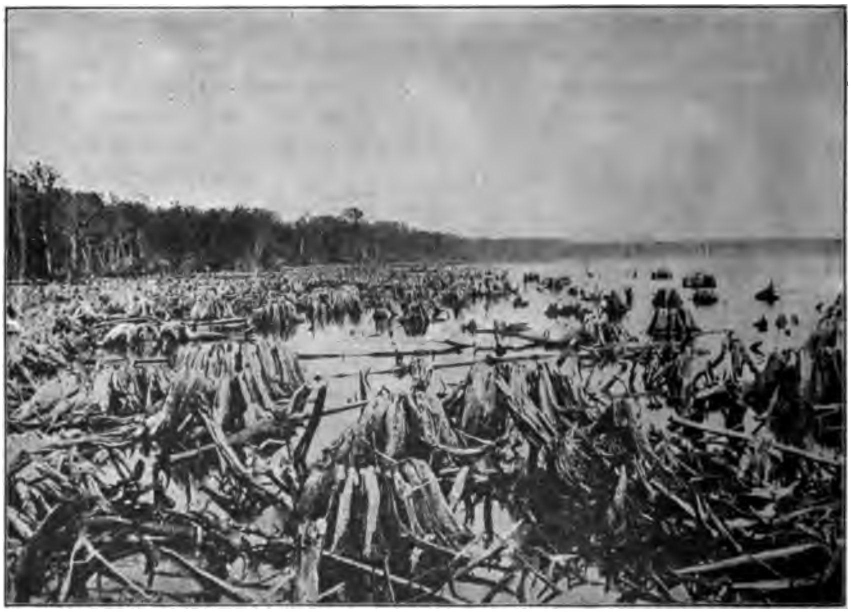

FIG. 56.—Cypress stumps on the margin of Lake Drummond.

The peculiarity of the aspect of Lake Drummond is enhanced by the multitude of gray old cypress stumps, worn by weather and water into a thousand fantastic shapes, that encircle the basin, standing in the shallow water near the shore (fig. 56). During very high water many of these stumps are completely submerged. A few small trees are still alive, relics of what must once have been a noble forest of cypress.

The lake is entirely surrounded by low, swampy woods. At two or three points, where the ground is slightly higher, are small clearings, the remains of old lumber camps. In a very few places, notably at the mouth of the Jericho Canal, soil is being deposited, and marshy flats, occupied chiefly by herbaceous vegetation, extend a little way into the lake. The total present area of these flats, when the water of the lake is at its normal level, is perhaps a hectare (2½ acres).

In spite of the slight differences of elevation already mentioned, the surface of the Dismal Swamp exhibits very little diversity, the variations from the highest ground to the lowest being insignificant to the eye, although sufficient to induce some alterations in the plant covering. A great part of the swamp is covered with standing water, which varies in depth at different seasons, but rarely, even in the wettest parts, exceeds 6 decimeters (2 feet), and is usually from 2 to 15 centimeters (1 to 6 inches). The several ditches or small canals that have been cut through the Dismal Swamp ordinarily contain about a meter (3 or 4 feet) of water. Usually in the early fall a considerable part of the swamp is sufficiently dried off for a number of weeks to be traversed dry shod, but in its normal condition the greater part is very wet.

The origin of the Dismal Swamp and of its central body of water, Lake Drummond, offers an interesting problem in historical geology, and one that has been much discussed, but it is outside the province of this paper.

Col. William Byrd, a commissioner appointed by one of the colonial governors of Virginia to fix the boundary between that colony and North Carolina, gives an entertaining account of the Dismal Swamp as he and his party of surveyors found it at that early day. I quote from "The History of the Dividing Line: Run in the Year 1728," one of the papers comprised in the "Westover Manuscripts of William Byrd, esq., of Westover," published at Petersburg, 1841. On their first day in the swamp Mr. Byrd's party were "blessed with pretty dry ground for 3 miles together. But they paid dear for it in the next two, consisting of one continuous frightful pocoson, which no creatures but those of the amphibious kind had ventured into before. This filthy quagmire did in earnest put the men's courage to a trial, and though I can not say it made them lose their patience, yet they lost their humor for joking. They kept their gravity like so many Spaniards, so that a man might have taken his opportunity to plunge up to the chin without danger of being laughed at."

"The ignorance of the borderers" concerning the Dismal Swamp is much complained of, "notwithstanding they had lived their whole lives within smell of it. * * * At the same time they were simple enough to amuse our men with idle stories of the lions, panthers, and alligators they were like to encounter in that dreadful place. * * * The surveyors pursued their work with all diligence, but still found the soil of the Dismal so spongy that the water oozed up into every footstep they took. To their sorrow, too, they found the weeds and briers more firmly interwoven than they did the day before. But the greatest grievance was from large cypresses, which the wind had blown down and heaped upon one another. On the limbs of many of them grew sharp snags, pointing every way like so many pikes, that required much pains and caution to avoid. These trees, being evergreens [sic] and shooting their large tops very high, are easily overset by every gust of wind, because there is no firm earth to steady their roots. Thus many of them were laid prostrate, to the great encumbrance of the way."

GEOLOGY.

It will be expedient to leave the description of the most recent superficial deposits of the Dismal Swamp region to the following chapter on "Soils," and to devote this section of the paper to a brief description of the underlying strata, so far as their character and extent have been determined, merely enumerating the uppermost deposits. The series of events which has created the surface topography and the arrangement of the underlying geological formations which we find in the Dismal Swamp region to-day has formed the subject of numerous publications, and will be described in the text of the Norfolk folio of the Geological Atlas of the United States, soon to be issued by the United States Geological Survey. While the present distribution of the vegetation of the region is undoubtedly in part a result of its past geological mutations, the subject is too extensive to be entered upon in this report, even were the data at hand for its proper presentation. Consequently we shall confine ourselves to a statement of existing conditions.

The most recent surface formation of the Dismal Swamp region consists, in the region designated as The Plain, of a soil usually loamy, but varying from almost pure sand, with an insignificant content of humus in the highest and best-drained portions, to a mixture of sand, silt, and considerable organic matter in the lower-lying lands. In the beach and dune area the surface formation consists entirely of fine white sand of marine origin. In the swamps, on the other hand, notably in the Great Dismal itself, occur heavy deposits of peat—vegetable matter in various stages of decomposition—which in many places reach a thickness of 3 meters (10 feet) and are sometimes 4½ meters (15 feet) thick. Toward the margins of the Dismal Swamp these vegetable deposits gradually decrease in thickness. Great numbers of trunks of large trees have been buried in the peat, and are often so well preserved as to be valuable for all purposes to which newly felled timber can be put.[1] The surface of the salt marshes is covered with a thin layer of brownish or gray silt, mixed with considerable decaying organic matter and saturated with water which contains usually 2 to 3 per cent of sodium chloride. Under this a layer of stiff, blue clay often occurs.

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[1] See N. B. Webster, Amer. Naturalist. vol. 9, pp. 260 to 262 (1875).

Beneath these various surface deposits are extensive layers of sands, clays, gravels, marls, and matter of organic (chiefly vegetable) origin, which slope gradually to the southeast and which have an aggregate thickness of more than 525 meters (1,750 feet). These in turn rest upon the strata of crystalline rocks which are exposed farther west, but in the Dismal Swamp region are everywhere deeply buried.

The formations above the rock floor represent all geological periods from Lower Cretaceous to Recent. The greater part of them were deposited unconformably, the general level of the Coastal Plain having suffered numerous oscillations during the time in which they were laid down. The following table of the several formations, giving their period, general character, and thickness wherever the last was ascertainable, is quoted verbatim from Mr. Darton's forthcoming paper:

Period.	Formation.	Character.	Thickness in meters (and feet).
Recent	Alluvium, etc. (unconformity).	River mud, marsh, beach sand, dune sand, etc.	0–18 (60).
Pleistocene	Columbia (unconformity)	Sandy loams, sands, and clays	3–9 (10–30).
Neocene	Lafayette (unconformity)	Gravel, orange sands, loams	7.5–12 (25–40).
	Chesapeake (unconformity)	Fine sands, clays, and diatomaceous deposits.	10.5 – 169.5 (35–565).
Eocene	Pamunkey	Glauconitic sands, marls, and clays.	9?–90 (30–300).
Cretaceous	Marine deposits (unconformity).	Clays and sands	0–150 (500).
	Magothy (unconformity)	Sands?	?
	Potomac (great unconformity).	Sands and clays	60–288? (200–960).
	Crystalline rocks	Granites, gneisses, etc	

The formations occupying the surface in the Dismal Swamp region are the Chesapeake, Lafayette, Columbia, and Recent. Marine fossils are abundant in the Chesapeake formation, fossil shells being present in some deposits in such quantities as to afford marls valuable for agricultural purposes. The inorganic matter which constitutes the bulk of all the formations consists of the detritus of rocks in the Appalachian and Piedmont provinces[1] to the west, which was carried seaward by streams during past ages, just as is happening to-day.

The Columbia formation, a comparatively thin layer of sands and sandy loams, forms the surface of almost every part of the Dismal Swamp region where very recent deposits (dune and beach sand, marsh silt, swamp peat) have not been laid down upon it. This sheet varies in thickness from 6 to 10 meters (20 to 35 feet). The formations lying beneath the Columbia are naturally exposed only in the valleys of the larger rivers, especially the Elizabeth, the James (Hampton Roads), and the Nansemond. A section through part of the Columbia deposits is exposed on the outer ocean beach, where it forms a low bench of clay, either above high tide or between the levels of ebb and flood (fig. 55). The materials belonging to this formation, which compose the subsoil of much of the region, vary considerably at different points, and comprise gravel, coarse sand (sometimes quicksand), fine sand, silt, and red, yellow, and blue clays, besides various mixtures of sand, silt, and clay.[1]

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[1] See footnote, p. 331.

In the greater part of the Dismal Swamp region water stands quite near the surface of the soil, so that the roots of all except the smallest herbaceous plants can readily penetrate to a depth at which water is abundant. All deep-lying water of the region, so far as has been ascertained, has a salty taste.

SOILS.

By FRANK D. GARDNER, *Assistant, Division of Soils.*

THE SALT MARSHES.

The soil of the salt marshes is usually a brown silt containing much partially decomposed vegetable matter, beneath which stiff clay is often present as a subsoil. Great moisture is the normal condition of this soil, and at high tide it is subject to overflow. As the water which then covers it is strongly brackish, the soil of salt marshes is characterized by a much higher percentage of common salt ($NaCl$) than is present in ordinary soils.

THE SAND STRAND.

The soil of the beach and dune area, like that of the salt marshes, possesses no agricultural value. It is an almost pure marine sand, whitish in color. Near the tide limit particles of carbonate of lime ($CaCO_3$) are somewhat abundantly intermixed, a result of the decomposition of seashells. Farther back, however, accumulation of lime is prevented by the dissolving action of rain water impregnated with carbonic oxide (CO_2). Humus is almost entirely wanting, except on the innermost, fixed dunes. Here the growth of trees permits a sufficient accumulation of vegetable matter to give the soil a grayish color. Elsewhere the sparseness of the vegetation, the ready permeability of the sand, the mechanical effect of the wind, and the rapid oxidation brought about by wind and sunlight are conditions which interfere with the accumulation of dead vegetable and animal matter.

Common salt, sodium chloride, is present in considerably larger quantity near the shore than is normally the case in inland soils. The presence of the salt is easily accounted for by the frequency with which spray is blown landward by the wind.

That the percentage of sodium chloride, as well as of calcium carbonate, which exists in dune sands at any considerable distance beyond the reach of the tides, is normally too small to have much influence upon vegetation is indicated by the researches of Massart on the Belgian coast. The following analysis of sand-strand soil is given in his paper:[1]

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[1] The Columbia formation is described by W. J. McGee, Am. Journ. Sci., ser. 3, vol. 35, pp. 120 to 143, 328 to 330, 367 to 388, 448 to 466, 1888; and by N. H. Darton, Bul. Geol. Soc. America, vol. 2, pp. 431 to 450, 1891.

Hygroscopic water	0.22
Free water	.28
Substances soluble in water	.02
SOLUBLE IN NITRIC ACID.	
Iron oxide	.14
Alumina	.13
Calcium carbonate	.14
Magnesium	.14
Carbon dioxide	.12
SOLUBLE IN SULPHURIC ACID.	
Alumina	.30
Phosphoric acid	Traces.
Insoluble	98.81
	100.00

Despite its excessive permeability, the soil is here rarely dry except at and very near the surface. Even on the dunes one can easily reach moist sand with his hands. Near tide level, as everyone knows, the shallowest depression soon fills with water. It is probable that only the smallest plants of this strand formation ever have difficulty in reaching a sufficient supply of water with their roots. Abundant deposition of moisture in the form of spray, rain, and dew, and the resistance to evaporation offered by the superficial layer of the sand, as well as by the abundant atmospheric humidity, are factors which sufficiently account for this, at first glance, somewhat anomalous condition. A further physical peculiarity of sand which is of interest in connection with the vegetation is the rapidity with which the surface layer absorbs a great amount of heat, while the moist underlying portion remains always cool. On the other hand, sand gives up its heat with equal rapidity. Consequently it receives after nightfall a heavy precipitation of dew.

THE PLAIN—TRUCK SOILS.[2]

GENERAL OBSERVATIONS.

That part of the Dismal Swamp region which belongs neither to the strand, the salt marshes, nor the wooded swamps we have designated

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[1] Mém. Soc. Roy. Bot. de Belgique 32, pt. 1 (1893); quoted from Swaelmen's "Le boisement de la côte belge" (1888).

[2] In the following publications of the Department of Agriculture Professor Milton Whitney has quite fully described the peculiarities of the so-called "truck" soils that occur along the Atlantic coast in the United States: Yearbook for 1894, pp. 129 to 143 (1895); Bul. No. 5, Div. Agr. Soils, pp. 15, 16, pls. 12 to 18 (1896); Bul. No. 13, Div Agr. Soils, pp. 8 to 11 (1898).

The Plain. It comprises the great bulk of those soils which are at present of the highest agricultural value. The lighter, sandier soils, which chiefly occur near tide water, are largely devoted to truck farming, the principal industry of the region. The ideal truck soil is light in texture, well drained, and easily worked, and has but a small natural content of organic matter. By a happy coincidence it is precisely this type of soil which usually borders tide water, not along the outer shore, where the sterile beach and dunes occur, but along the numerous bayous and estuaries which intersect the coastal plain in so bewildering a fashion. The value of the truck lands is thus enhanced by the protection against late and early frosts which the neighborhood of the sea affords, and by the ease with which their products can be shipped to a distance by water.

These three conditions are almost essential to profitable market gardening on a large scale when the object is, as here, to force vegetables to early maturity, in order that they may reach the large Northern cities well in advance of the home-grown product. Inland soils can rarely compete with those lying in the immediate vicinity of salt water: (1) Because they are usually too heavy, containing too high a percentage of silt or of clay in proportion to their sand content. The consequence is that they retain too much water and are slower to warm up at the beginning of the season, while also they become cold earlier in the fall than do lighter soils. For these reasons they are much more liable to the effects of late or of early frosts than soils near the coast. All these soil conditions are obstacles to the quick development of early vegetables. (2) Because they are too far from the sea, with its moderating influence upon temperature in spring and fall and with its facilities for cheap transportation.

It must not be understood, however, that there is any single type of soil which meets the requirements of all truck crops alike in the fullest degree. A soil that is light, sandy, and without a stiff clay bottom to a depth of 4 or 5 feet is admirably adapted to sweet potatoes and melons, but is less suitable for potatoes, strawberries, and peas, while distinctly unfitted for cabbage and spinach. In such land a ten or twelve days' drought will burn out potatoes.

In the fine truck region about Norfolk two well-defined types of soil are recognized by some farmers. One is a light loam, possessing only a thin clay bottom, beneath which there is often a bed of quicksand. This type is best suited for growing strawberries, and yields excellent cabbages, although it is not the finest kind of soil for the latter vegetable. The second is characterized by a sandy soil 12 to 18 inches deep, with a subsoil of clay sometimes stiff enough to be used for brick making. Potatoes and tomatoes are said never to rot in such soil, as frequently happens when they are put into that of the first type. This is also considered a superior soil for cucumbers.

Certain of the truck crops, especially those which are sown in the spring, require for their early maturity a very light, dry soil, containing not more than 9 per cent of clay. Such are watermelons, muskmelons or cantaloupes, sweet potatoes, cucumbers, asparagus, and, when early maturity is very important, Irish potatoes. On the other hand, fall-planted crops are better adapted to heavier land, having a clay content of from 6 to 12 per cent. Spinach and cabbage are good examples of this class, and, as a general thing, strawberries, tomatoes, peas, and beans give somewhat better results on the heavier truck lands.

By some truck growers two principal types of land are distinguished near Newbern, N. C.: (1) A light yellow loam, excellent for peas and tomatoes, and for Irish potatoes, which have a fine white color when raised in this soil; (2) "gall-berry" land, which is richer in organic matter, and consequently black in color. The surface soil is sandy, clay is encountered in some quantity 2 to 3 feet below the surface, and a solid clay bottom occurs at a usual depth of 5 or 6 feet. Soil of this kind is warm and easily worked, but needs to be well drained, else it will "drown out" in very wet seasons. At all times it is decidedly more retentive of moisture than is the yellow loam. Gallberry land is considered by some "truckers" as unexcelled for strawberries, and for Irish potatoes, which are said to be better in size and flavor, although less attractive in color, than when grown in the yellow loam.

It can be said of this region that the natural drainage is almost everywhere deficient. Even the coastwise soils, which seem quite light and dry in their original condition, are nevertheless found to require at least cross furrowing before they are in fit condition for raising truck crops. On most of the large farms a system of tile drainage or of open ditches, intersecting every field, is employed.

Another point is that the very light soils near the coast, which are best fitted for forcing vegetables to early maturity, are all but worthless in their primitive condition. Only by the heavy application of fertilizers can they be made to yield good crops. The annual outlay for fertilizers is an item that should be well considered by anyone who contemplates truck farming. Some idea of the amount of money thus expended may be gained from the fact that on one farm near Norfolk $16,000 to $17,000 is paid out each year for commercial fertilizers. On the larger farms $60 to $75 worth of fertilizers per acre is used.

The cultivated truck soils are often slightly acid, although far less so than are swamp lands. This is believed to be due rather to artificial than to natural conditions. The long-continued use of fertilizers is held responsible by some truck growers for the sourness of their land. Whatever its cause, the result is frequently injurious to the crops, especially Irish potatoes, which are liable to rot in sour land. Application of lime, usually in the form of burnt shells, is a remedy which is found efficacious in most cases. Those who deny that this treatment is beneficial have probably been too impatient, and have not allowed sufficient time for the chemical changes by which the acid is neutralized.

DESCRIPTIONS AND ANALYSES OF SAMPLES.

The descriptions and analyses of a series of samples taken from typical soils of The Plain will show better than any general discussion which are and which are not best suited to truck and other crops. Four samples from Newbern, N. C., are added to those from the Dismal Swamp region for purposes of comparison.

Beginning at the north and taking the samples as they occur in geographic order, going south, we have first sample No. 1599, which is a subsoil at from 12 to 30 inches, from Ballantine's farm near Eastern Branch, Norfolk, Va. It contains 14.35 per cent of clay, and while considered a good truck soil, is too heavy in texture to be as early as some other soils of the region.

Sample No. 1601 is also a subsoil at from 12 to 30 inches from the same farm, but is from land that needs drainage. Its texture is better suited for early truck than is No. 1599, because it contains little more than half as much clay. If drained it should make good early truck land.

Sample No. 1593, from the farm of William Wise, and No. 1595, from Henry Kirn's farm, are subsoils at from 9 to 30 inches, both from near West Norfolk, Va. They represent what is known as the finest type of early truck land, and it will be well to note carefully their texture. They are quite similar and contain about 8 per cent of clay and from 20 to 25 per cent of silt, the rest being largely medium and fine sand.

No. 1579, from the thirty-fifth milepost, Currituck County, N. C., represents the subsoil characteristic of the clay lands in that vicinity. It contains about 25 per cent of clay and is therefore much too heavy for truck. It would do well for corn, wheat, and pasture land.

No. 1570 is a sample from Camden, Camden County, N. C. It is a light sandy soil well suited to medium and late truck.

No. 1571 is also from Camden and represents the texture of the clay at 4 feet in depth, which underlies all of the Elizabeth City lands.

No. 1566 is a subsoil at from 9 to 30 inches and is from the farm of Dr. E. F. Lamb, Elizabeth City, Pasquotank County, N. C. This soil is well suited to truck.

Nos. 1519 and 1520, subsoils at from 7 to 24 and 24 to 30 inches, respectively, are very similar in texture. They are too heavy for any but late truck. Owing to their proximity to the river they are exceptionally free from frost.

No. 1510 is from 2 miles south of Chapanoke, Perquimans County, N. C. It is a heavy, stiff, close, tenacious, wet subsoil underlying a deep black loam. It contains over 25 per cent of clay and is therefore not suited to truck. It would make good grass and wheat land.

No. 1512 is a subsoil from one mile south of Chapanoke, N. C., and is much lighter in texture than the preceding sample. It would probably be well adapted to truck.

No. 1558 is from No. 4, Leigh's farm, near the point, Durants Neck, Perquimans County, N. C. It is a subsoil of from 9 to 30 inches, and contains 32 per cent of clay and 30 per cent of silt. It is too heavy for truck, but is well suited to corn, wheat, and cotton.

No. 1534 is a subsoil at from 5 to 30 inches, and is from the farm of S. S. Woods, at Hertford, Perquimans County, N. C. It contains 6½ per cent of clay and 70 per cent of fine sand, and would be well adapted to early truck.

No. 1524, from 1½ miles north of Edenton, Chowan County, N. C., is from Dr. Hoskin's place. It is a subsoil at from 5 to 30 inches. It contains less than 3½ per cent of clay, and would therefore be called sand. It is excellent for early truck.

No. 1522, from the farm of J. G. Wood, of Edenton, N. C., is a subsoil at from 8 to 30 inches, and contains about 16 per cent of clay. It is overlaid by a loam soil, but is rather too heavy for truck. It would probably make good cotton land.

No. 1517 is a subsoil at from 5 to 30 inches, and is from the farm of J. L. Rhems, of Newbern, N. C. The soil is a light sandy loam and well adapted to truck.

No. 1510 represents the type of earliest truck land on Hackburn & Willett's farm, Newbern, N. C. Its texture is too light for cabbage, but is excellent for potatoes. Crops ripen from four to eight days earlier on these lands than on the heavier cabbage lands, and, with proper attention, two weeks earlier than at Norfolk.

No. 1514 is also from Hackburn & Willett's farm, and represents the subsoil at from 14 to 30 inches of the cabbage and spinach land. This type of land averages from 200 to 225 barrels of cabbage per acre.

No. 1515 represents the texture of the subsoil below 3 feet, underlying both the early truck and cabbage lands.

The subsoils are given here because it is upon their texture that the character of crops is mostly determined. The complete mechanical analyses of all the foregoing samples are found below.

TABLE A.—*Mechanical analyses of subsoils.*

No.	Locality.	Description.	Gravel (2-1 mm.).	Coarse sand (1-0.5 mm.).	Medium sand (0.5-0.25 mm.).	Fine sand (0.25-0.1 mm.).	Very fine sand (0.1-0.05 mm.).	Silt (0.05-0.01 mm.).	Fine silt (0.01-0.005 mm.).	Clay (0.005-0.0001 mm.).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1599	Virginia	Ballantine	0.00	2.67	25.17	5.12	10.16	31.45	8.88	14.35
1601	do	do	0.00	0.27	42.12	12.96	6.63	20.20	4.79	8.88
1595	West Norfolk, Va	Henry Kirn	0.00	1.42	23.27	38.25	7.51	15.14	5.90	7.15
1593	do	Wm. Wise	0.00	0.64	24.09	41.03	5.71	11.54	7.33	8.40
1579	35th milepost, North Carolina.		0.00	0.00	0.00	0.55	24.11	33.33	11.06	24.72
1570	Camden, N. C		0.00	2.46	5.17	19.79	33.53	19.69	7.11	10.35
1571	do		0.00	0.00	2.28	3.15	46.50	20.54	5.64	16.82
1520	Elizabeth City, N. C	W. M. Baxter	0.00	0.00	4.98	8.87	44.97	19.20	5.88	13.62
1519	do	do	0.00	0.00	2.07	4.75	39.16	30.04	6.27	14.37
1566	do	Dr. E. F. Lamb	0.00	0.00	4.94	6.11	43.61	25.73	7.27	9.20
1540	Chapanoke, N. C., 2 miles south.		0.00	0.00	1.49	6.32	20.35	36.78	7.43	25.58
1542	Chapanoke, N. C., 1 mile south.		0.00	0.00	7.68	41.77	13.05	18.92	5.03	12.37
1558	Durant Neck, N. C	Leigh farm	0.00	0.00	0.00	0.20	38.03	29.54	8.17	22.15
1534	Hertford, N. C	C. S. Wood	0.00	0.00	6.37	68.34	9.67	7.55	2.35	6.47
1522	Edenton, N. C	J. G. Wood	0.00	1.13	6.11	20.58	27.82	18.37	7.79	15.85
1524	do	Dr. Hoskin	0.00	0.00	4.74	36.16	38.71	10.27	4.18	3.40
1517	Newbern, N. C	J. L. Rhems	0.00	3.91	22.60	29.03	22.38	7.03	3.16	10.32
1510	do		0.00	0.30	6.04	49.63	32.39	6.24	1.93	2.80
1514	do	Hackburn & Willett.	0.00	2.04	10.57	10.65	22.75	30.22	8.95	13.12
1515	do	do	1.19	8.09	29.69	16.11	11.43	14.36	2.53	13.55

THE WOODED SWAMPS.

The data for the following discussion were obtained in the Dismal Swamp proper, although what is said of the great morass will apply with equal force to the soils of other forested swamps in the region.

ORGANIC MATTER.

The accumulation of partially decomposed vegetable matter in this area is quite remarkable, being more than 3 meters (10 feet) in depth over considerable areas. With Congo-red test paper it shows a strongly acid reaction. It is the product of many centuries of vegetation, laid down little by little with practically no disturbance, so that there is only the slightest trace of soil in much of it. Upon ignition at a low red heat 94 per cent of it passes off as combustible material. Two leading types of vegetable deposits are easily distinguishable—those of the "Juniper" or "light" Swamp and those of the "Black Gum" or "dark" Swamp.

The first, a true peat, is found in the extensive tracts which are or were covered with the "juniper" or white cedar. Here the maximum thickness of the deposits appears to be about 3 meters (10 feet). Decomposition has progressed very little in this case. The peat consists of a reddish-brown mass of stringy consistency and is composed in great part of the wood, bark, and leaves of the "juniper." Owing to the antiseptic quality of the water, logs and even stumps *in situ* are so well preserved in this peat that when exhumed they often make valuable timber. When juniper land is cleared and drained the surface peat has a strong tendency to "cake" and harden beneath the sun's rays until it resembles charred wood. Consequently, juniper land is considered practically worthless, and its successful cultivation would undoubtedly entail a very heavy preliminary outlay.

While peat is used in the northern countries of Europe as fuel, all attempts to bring it into use in this country have been failures. Peat has a very great power of holding water. Being much like a sponge in texture, it will hold from two to ten times its own dry weight of water. Wet peat upon losing its water and becoming dry usually contracts to one-half or even less of its former volume. In New England peat is used in the compost heaps, and in this way becomes a manure of considerable value. The amount of plant food it contains is often small, but varies much with the nature of the vegetation from which it originated. The peat of the Dismal Swamp being largely from trees ought to be fairly valuable. Its greatest usefulness, however, will probably be in the physical effect that it will produce in the soil. Many soils are sadly deficient in humus, and for supplying this peat will do quite well. It is a question if much of this peat of the swamp could not be economically used on the very sandy truck farms, many of which are located within a short distance of the swamp. The principal part of the transportation could be cheaply made by water. The value of peat for this purpose could be experimentally determined at a very small outlay.

The second type of deposited vegetable matter has been laid down in those portions of the morass, especially around Lake Drummond, which bear a forest of black gum, cypress, and red maple (Pl. LXVII). In places the beds reach a thickness of 3, or even, according to Prof. N. B. Webster,[1] of 4½ meters (10 to 15 feet). The color is black. Decomposition has here progressed further than in the "juniper" deposits, and the black gum type is to be regarded as a form of humus, rather than of peat. When cleared and drained, black gum lands afford a rich, mellow top soil, which differs markedly from the stubborn juniper lands in being tractable and easily worked.

The following are determinations of the percentage of organic or combustible matter in such soil at each of three depths:

Per cent organic matter in soils.

Depth.	Virgin soils.	Soil cultivated 20 years.	Soil cultivated 50 years.
cm. 0- 50 in. 0- 20	13.10	6.90	5.10
cm. 50-100 in. 20- 40	3.30	2.40	2.10
cm. 100-150 in. 40- 60	1.90	1.40	1.00

This table shows that the largest part of the organic matter occurs in the upper 20 inches and that it decreases in amount for each succeeding 50 centimeters (20 inches) in depth. It furthermore shows, as one would naturally suspect, that the virgin soil contains more organic matter than that under cultivation, and that the longer the time of cultivation the smaller the content of organic matter. This holds true for each of the three depths, although the maximum change is in the upper 20 inches. Yet, even where cultivation has been continued for fifty years, the soil still has enough organic matter to give it a black color. In some places this black color extends into the second 20 inches, but is usually absent, the second and third 20 inches being ordinarily of a yellowish color. This abundance of organic matter is of great importance since it (1) furnishes a large amount of nitrogenous plant food, (2) increases the water-holding capacity of the soil, and (3) by its black color increases the power of the soil to absorb heat. The increased power to absorb heat is no doubt more than overcome by the cooling tendency of the increase in water content, due to the organic matter. From the standpoint of the early trucker this reduction in temperature would be a serious objection, because it would retard the maturity of his crops and throw them on the market when prices are usually much reduced. Aside from this objection, however, the organic matter is of great value.

ACIDITY.

The virgin soil is invariably very acid, doubtless because of the enormous accumulation of vegetable matter and the consequent retardation of the drainage. Aeration of the [illegible]ssarily very imperfect under such conditions. It is the [illegible] pe[illegible] farmers in the region that new fields when brought under cu[illegible]n are much benefited by liberal applications of lime. Even after being cultivated for twenty years the soils are still slightly acid and would doubtless be improved by further treatment with lime. Lime neutralizes the acids, and this is undoubtedly the principal advantage of its use on swamp soils. It is usually applied here in the form of burnt shells, about one ton per acre being the amount used on the swamp soils. The total cost of adding to the land this quantity of lime is estimated at about $4.50 per ton.

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[1] Am. Naturalist, vol. 9, p. 260 (1875).

Portions of the swamp on which "juniper" abounds are of very little value agriculturally, and since even the waters flowing from these parts of the swamp are strongly acidified it may be that the presence of large amounts of acid is one of the causes of this nonproductiveness. Whatever the cause of the acidity, it is gradually reduced when the soil is drained and exposed to the air, so that decomposition can proceed.

CLAY CONTENT.

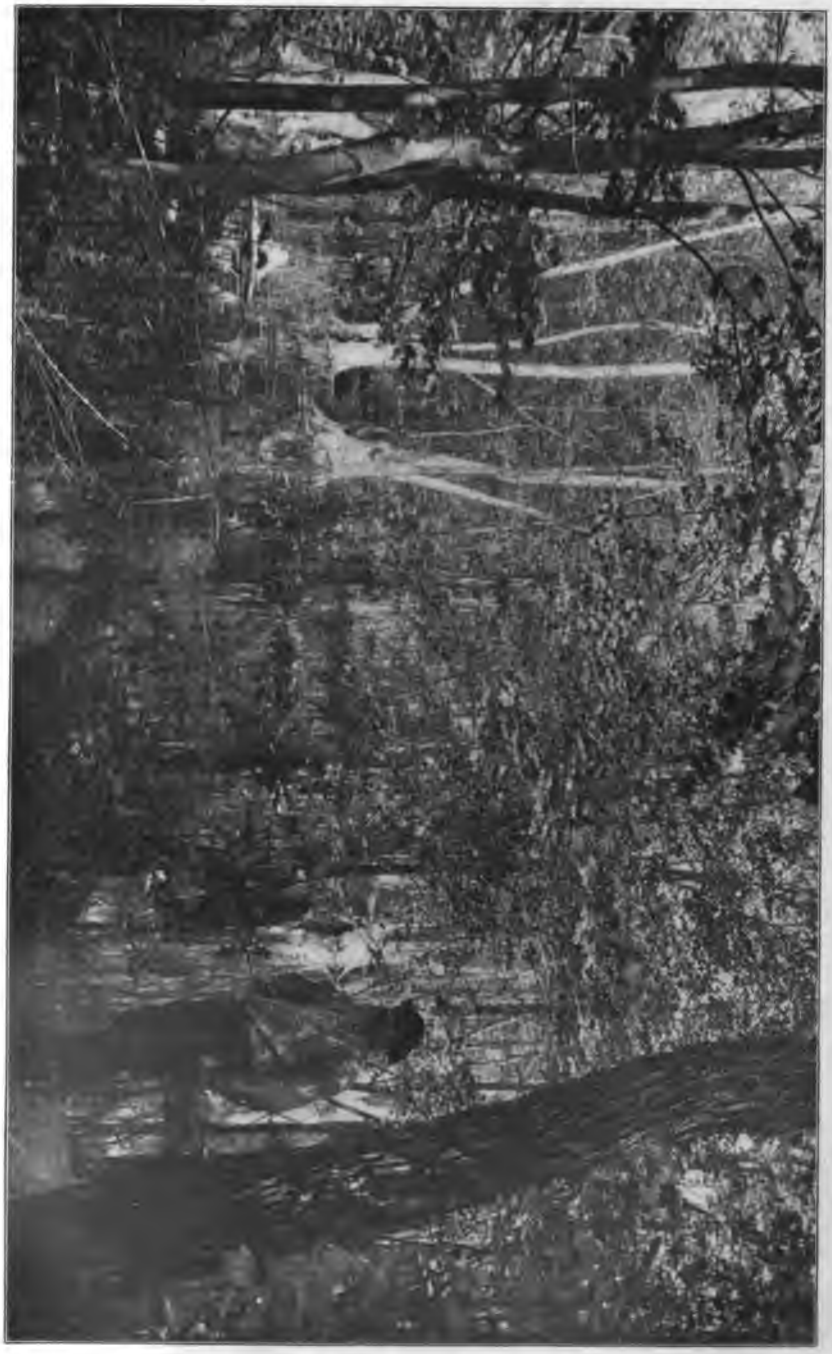
The distribution of the clay content of these soils, as shown by the following table, is very interesting:

Per cent of clay in soils.

Depth.	Virgin soils.	Soil cultivated 20 years.	Soil cultivated 50 years.	Mean.
cm. 0-50 in. 0-20	11.60	11.10	7.80	10.17
cm. 50-100 in. 20-40	23.35	18.65	18.40	20.13
cm. 100-150 in. 40-60	16.65	16.50	12.35	15.17
Mean....	17.20	15.42	12.85	....

It will be seen that the per cent of clay at 0 to 50 centimeters (20 inches) is in each soil less than at either of the other depths, while at 20 to 40 inches it is greatest. This is a very fortunate distribution of the clay content for this particular region. The mean clay content of 10 per cent at 0 to 50 centimeters gives a texture that is very easy of cultivation and one that can be cultivated very soon after rains without injury to the structure of the soil. On the other hand, when taken in connection with its high per cent of organic matter and the character of the succeeding 20 inches in depth, it is sufficiently heavy to be adapted to a fairly wide range of crops.

The mean clay content of 20 per cent at 50 to 100 centimeters (20 to 40 inches) is just twice that of the surface 20 inches and gives a texture sufficiently heavy to be subject to but little leaching. This will prevent any considerable loss of plant food that is now present or that



VIEW IN THE BLACK GUM SWAMP.

may in the future be added in the way of fertilizers. It also gives a stratum with sufficient capillary power to draw water from a considerable depth below, which would be of great value in times of drought.

The mean clay content of 15 per cent at 100 to 150 cm. is just midway between that of the first and second 50 cm., and is not sufficient in quantity to prevent a fairly free lateral movement of the ground water at this depth. This is very important, since the success of underground drainage depends largely upon the free lateral movement of ground water at about the depth at which tile drains are usually laid. The whole of the Dismal Swamp area will require thorough underdrainage before it can be brought to a high state of cultivation, hence the importance of the texture of the soil at this depth. The clay content of a soil, when coupled with its organic matter, is the controlling factor in relation to its structure and water capacity.

TEXTURE.

The table on page 358 gives a complete mechanical analysis of eleven samples of soils from the Dismal Swamp, one from West Norfolk, and one from Illinois. As may be seen from the mean of the first nine analyses, the soils of the swamp to a depth of 1.5 meters (5 feet) contain, on an average, approximately 50 per cent of fine sand, the particles of which range from one-fourth to one-tenth of a millimeter in diameter. The next largest separation is that of clay, of which we have already spoken. These analyses show that the soils would properly be classed as sandy vegetable loam. The light texture of the upper 20 inches makes the soil easy of cultivation, and fields that have been in crops annually for fifty years are still in the best of mechanical condition.

Only two samples were taken below 3 meters (10 feet) in depth, and those show considerable difference in texture. No. 3928 was material taken from the bottom of the canal by the dredge, and had been exposed to the weather upon the canal banks for some time. It is not at all improbable that the rains had carried away most of its silt and clay, which may account for the small amounts of these separations shown in the analysis. Sample No. 3933, however, has a much less amount of fine sand and much more of medium and coarse sand.

Sample No. 302 is black prairie soil from Illinois, where underground drainage is practiced on a large scale in preparing land for the production of corn, grass, and wheat. A comparison of its texture with that of the soils of the Dismal Swamp shows the latter to have half as much clay as the former, and approximately one-fourth as much fine silt and silt. For thorough drainage in the prairie soils the lines of tile drains are seldom laid nearer than 150 feet from each other, and, judging from the comparative texture of the two soils, successful drainage could be accomplished in the swamp soils by having the lines of drains 300 feet apart. In fact, experience shows that open ditches 4 feet deep and 300 feet apart afford ample drainage for the swamp soils from which the above analyses were made. Underground tile drains could be used at intervals equally great with as good success, and would have many advantages over the open ditches, which will be spoken of under the head of drainage.

Sample No. 357 is from the finest truck land near West Norfolk, and is here introduced for comparison with the swamp soils in order that we may judge of their fitness for early trucking. Excepting the organic matter, the two soils are very similar in texture when we compare them at corresponding depths. The swamp soil has approximately five times as much organic matter as the truck soil, which, together with its slightly greater amounts of clay, silt, and very fine sand, gives it an appearance very different from the latter.

The slightly heavier texture, together with the high per cent of vegetable matter, very much increases the water-holding power of the swamp soil, and as a result makes it colder in the early season. This promises crops of larger growth, but they will be much later in maturing, and since earliness is the chief factor on which the success of the trucker depends, this soil can not be expected to compete successfully with that about West Norfolk in truck crops, except in case of a few crops where earliness brings no particular advantage, as in the case of late potatoes, cabbage, and celery. These crops could certainly be grown at less expense for fertilizers and no greater expense for cultivation and marketing than those of the famous truck areas. When drained and put in a good state of cultivation, there is no doubt that a large portion of the swamp area would be well suited to the growth of celery. With a minimum amount of drainage, the borders of the swamp might be used for the growing of cranberries and the water from the interior used to flood them.[1]

For special crops, to which the swamp soil is adapted, much of it could doubtless be economically used. In order to succeed, it would of course require good business ability and a knowledge of the requirements, management, and marketing of the crop to be grown. There is no doubt that the swamp soils, under proper treatment, will prove very valuable for those crops to which the environment as a whole is favorable. When thoroughly drained, swamp soils in general are among the most productive and lasting. With the present demand for lands, it is a question if it would prove profitable to deforest and drain the whole of the swamp area, though it could be done at a moderate expense. The value of the timber removed would, in part at least, pay the expense of its removal. By drainage sufficient to lower the water 12 to 18 inches below the surface fire could be used as a means of destroying the timber, and at times of drought considerable portions of the peat could no doubt be burned if so desired. After drainage the change in the character of the area would be very great. The peat would contract to a very much smaller volume in losing water, and would oxidize to a considerable extent.

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[1] The cultivation of celery in the region, as well as the possibilities of cranberry growing, are discussed under the head of "Agricultural products."

WATER.

The water of Lake Drummond and, in fact, all water in the swamp is amber in color, and, after very heavy rains or unusual agitation, is quite turbid. For the most part it is slightly acid, and when issuing from areas where the juniper abounds, is markedly so. The water often tastes of the wood of cypress or juniper, and is said to have remarkable preservative properties. It is noticeable that there are none of the offensive odors in the Dismal Swamp which are so common about fresh-water swamps or ponds elsewhere, e. g., in the prairie region. Formerly the water from the swamp was barreled and used in ship voyages across the ocean. The movement of the water in the swamp is very slow, being greatly impeded by the dense growth and the great accumulation of peat. When the land is cleared of vegetation, however, it is easily drained. The subsoil, being sandy, admits of quite rapid movement of the water.

DRAINAGE.

The labor expended in the past in draining areas around the periphery of the Dismal Swamp would, if directed with regard to the best present-day systems of drainage, have sufficed to drain the whole of the area. The old drainage systems now in use were planned by each owner for himself, without any relation to a general scheme of drainage. There are many miles of open ditches, most of which were completed before the middle of the present century. Their construction was made at an enormous outlay, and the annual expense of removing the vegetation and soil that accumulates in them each year is considerable. At least 90 per cent of these open ditches could as well be replaced by underground drains of tile, only the larger or main ditches being left open. By means of underground drains the annual expense of clearing ditches would be done away with. The additional cost would be that of the tile only, and, indeed, this would be partially offset by the smaller amount of excavating required. A ditch to receive tile needs to be no wider than is required for the digger to work advantageously, and its sides may be perpendicular, while a ditch which is to remain open must be several feet wide at the top in order that the sides shall not cave and fill the ditch. This greater width may more than double or treble the amount of excavation required, which would largely offset the cost of tiles and, in the case of small tiles, might exceed their entire cost. Then, again, the tile drains can be laid in any direction, without conforming to the shape of the fields, and better drainage may be secured with shorter ditches than would be the case with open ones which have to follow the borders of fields. This also may reduce the amount of excavating.

By the use of tiles all open ditches excepting main ones are done away with. Instead of many small fields, bounded on all sides by deep ditches, entailing much turning with teams and implements in the process of plowing and cultivating the crop, the whole farm may be in a single field. The small fields are accessible at one point only by means of a bridge. The ditches occupy much land and afford a harbor for weeds and noxious plants, which have to be cut down annually and removed at much expense.

A farm of 800 acres on the west side of the Dismal Swamp canal has open ditches every 400 yards one way and every 100 yards the other. This makes each of the small fields contain about 8 acres. There would be 100 of these fields in the whole farm, and the length of ditches would therefore be 50,000 yards, or 28 miles. Assuming that the width of land taken up by a ditch and its borders is 1 rod, which is about the average, 56 acres would thus be occupied and would produce nothing but weeds. This amounts to 7 per cent of the farm.

The whole of the swamp is susceptible of drainage. As it has an adequate fall for an artificial flow of waters and a subsoil sufficiently sandy to admit free movement of water, the tiles need not be nearer to each other than 300 feet. The vegetable matter in the soil would prevent the banks of the necessary open ditches from caving badly.

During the last two years the Dismal Swamp canal has been considerably deepened, and all locks except one at each end have been removed. The water, therefore, now stands some 6 feet lower than it formerly did, and this will afford ample outlet for all of the district west of it. By running tributary ditches west from the canal at intervals of every 2 miles and extending them back to near the Nansemond Escarpment, a distance of about 10 miles, the whole of this area could be easily drained. These tributary ditches should be 8 or 10 feet wide where they enter the canal and of a depth of 2 or 3 feet below the level of low water in the canal. It might be advisable to have here and there smaller ditches tributary to these main ones, owing to some local peculiarity in the lay of the land, but most likely the entire remainder of the drainage could be done by tiling.

It is somewhat a question if, with the present demand for agricultural lands, it would pay to deforest and drain these swamp lands to be used in producing corn, as the redeemed portions are at present largely employed. It would hardly seem probable that this region could compete with the corn States of the Ohio and Mississippi valleys, where the land is easily brought under cultivation and the best methods and machinery are used in its production. Nevertheless, as far as experience goes, the swamp soils are capable of producing as large yields of corn as are the prairie soils of the Mississippi Valley, and the climatic conditions as a whole are more favorable than is the case in the latter territory. Owing to its close proximity to the ocean the Dismal Swamp has a longer growing season. Then again the normal monthly rainfall for the summer months is about 30 per cent greater than in the Mississippi Valley. The following table shows the normal monthly precipitation in inches for the two region compared:

Comparison of precipitations.

Place.	Number years.	Apr.	May.	June.	July.	Aug.	Sept.	Total.
Norfolk, Va	26	4.3	4.2	4.4	5.8	6.3	4.7	29.7
Peoria, Ill	41	3.2	3.8	3.7	4.0	3.0	3.5	21.2
Keokuk, Iowa	24	3.2	4.1	4.5	4.1	2.8	3.5	22.2

The month of August in the Mississippi Valley is most frequently the dry month that cuts short the crop. From the table it will be seen that on an average Norfolk, which is but a few miles north of the swamp, has more than twice as much rain in August as have the places in the Mississippi Valley. Furthermore, the water table is so near the ground surface and the subsoil is so light in texture that with good methods of cultivation drought is almost unknown in the Swamp region. This insures a good crop every year, while in the Mississippi Valley there is a shortage in the corn crop on an average once in every three years, due to insufficient moisture in the soil. This gives a great advantage to the swamp lands.

Again, the Dismal Swamp is at the very door of a magnificent seaport where produce can be loaded on ships for transportation to almost any point in the world. Since the transportation canal runs through the swamp produce could be taken almost immediately from field to boat and transported in this way to any of our Eastern cities, Baltimore, New York, Philadelphia, or Boston. The expense of transportation would be considerably less than by rail from the Mississippi Valley to any of these cities.

Upon careful study it will be found that the location, climate, and soil of the swamp are such as to give it many advantages, even for the production of a great staple like indian corn. The soil, being sandier than that of the prairies, is more easily cultivated. On the other hand, when we consider the superior facilities for transportation, it is clear that there is much to be said in favor of more intensive farming on land reclaimed from the Dismal Swamp. Potatoes, cabbage, and celery are crops that do well on such land; and, with proper management, they could undoubtedly be made profitable here.

SOIL ANALYSES.

TABLE B. *Mechanical analyses of soils and subsoils.*

No.	Locality.	Description.		Moisture in air-dry sample.	Organic matter.	Gravel (2-1 mm.).	Coarse sand (1-0.5 mm.).	Medium sand (0.5-0.25 mm.).	Fine sand (0.25-0.1 mm.).	Very fine sand (0.1-0.05 mm.).	Silt (0.05-0.01 mm.).	Fine silt (0.01-0.005 mm.).	Clay (0.005-0.0001 mm.).
			Inches.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
3821	1 mile west of Wallaceton, Va. Edge of swamp.	Virgin soil	0-20	1.72	13.10	T.	1.28	2.75	34.15	19.78	10.01	5.21	11.60
3822			20-40	1.24	3.30	T.	.20	1.45	34.05	20.23	10.93	4.83	23.35
3823			40-60	.96	1.90	.....	.15	2.00	47.30	19.25	7.95	3.08	16.65
3829	Wallaceton, Va., 300 yards west of Dismal Swamp Canal.	In corn for 20 years continuously.	0-24	1.32	6.90	T.	.95	7.75	50.53	8.68	7.70	4.42	11.10
3830			24-44	1.22	2.40	T.	1.13	5.63	50.13	9.15	7.61	3.96	18.65
3831			44-60	1.00	1.40	T.	.63	4.88	58.10	8.78	4.82	2.82	16.50
3824	Wallaceton, Va., 100 yards east of Dismal Swamp Canal.	In corn for 50 years continuously.	0-21	.84	5.10	T.	1.15	7.25	54.45	8.20	10.68	3.16	7.80
3825			21-40	.97	2.10	T.	.90	6.40	48.38	6.15	12.13	3.35	18.40
3826			40-60	.97	1.00	T.	.50	3.25	67.95	8.80	2.80	1.05	12.35
	Mean of above.			1.14	4.13	T.	.77	4.60	49.45	12.11	8.29	3.65	15.16
357	West Norfolk, Va.	Finest truck land. 9-18 inches.		.56	1.06	0.04	.46	18.26	53.83	5.84	6.03	4.39	8.78
312	Champaign, Ill.	Prairie soil		.....	.....	1.04	1.98	6.85	6.23	5.82	28.38	15.46	30.00
3828	Wallaceton, Va., 1 mile north.	Sand dredged from canal, 10-14 feet.		.17	.20	.....	.40	1.73	79.00	16.25	.82	.07	.15
3833	Lake Drummond, Virginia.	Sand bored from bottom of feeder 12 feet deep.		.48	2.12	T.	6.79	30.69	15.07	15.32	6.03	3.46	11.62

THE PLANT COVERING OF THE REGION: ITS PHYSIOGNOMY AND ECOLOGY.

One of the most important functions of plant geography is the description of the vegetation of each floral region as it actually occurs in nature, apart from the systematic relationships of the species and the historical-geographical affinities of the whole flora. A word picture is given of the facies or physiognomy of the plant covering as a whole, and of the various assemblages of species—formations and associations—which occupy the different soils, overlying the several geological formations. In the Dismal Swamp region, owing to the uniformity of its geology and the comparatively slight physical and chemical differences of its soils, the principal factor in effecting a differentiation of the plant formation is the nature of the drainage. Only the plant growth of areas bordering immediately upon salt water is affected to any great extent by the chemical composition of the soil. Elsewhere it is chiefly a question of whether the substratum possesses a greater or less water content.

In order to an intelligible description of the physiognomy, a classification of the several plant assemblages of the region is necessary. The following arrangement appears to be, on the whole, the most simple and logical. It must not be supposed that the natural limits of the formations and associations are sharply defined. On the contrary, between neighboring assemblages there is usually a debatable ground, which might be reckoned to either. Thus the forests of the plain pass by insensible gradations into the xerophile woods of the inner strand on the one hand, into hygrophile forest or wooded swamp on the other. Between the dry sand strand and the wet salt marsh there is almost invaribly a neutral belt, and so in most other cases. Nevertheless, the plant formations are well-marked features of the landscape, that can be recognized by any traveler. Indeed, next to the water courses, the plant formations are the most important elements in the landscape of the flat Coastal Plain.

In the following discussion of the plant formations of the Dismal Swamp region, their physiognomy and taxonomic composition, with special regard to abundant and conspicuous species, are first described. Then follows, under the head of each formation, or formation class, a sketch of the more prominent ecological characteristics, preceded by a discussion of the life conditions. What may be termed biological forms—in contradistinction to systematic forms—and, in general, the more obvious adaptations to environment, are briefly treated. The ecology of the sand strand and of the palustrine forest is discussed at greatest length, because in these formations life conditions are extreme, and adaptations thereto are numerous and easily detected. This is likewise the case with the salt marsh and the aquatic formations, but here most of the biological, like the taxonomic forms, are of wide distribution on the surface of the globe, and have been described in many other publications. Hence it has seemed advisable to treat these formations more briefly. The sand strand and the salt-marsh formations of the North Carolina coast were described in an earlier paper;[1] and as the species, especially of the salt marsh, are largely those that occur on the Virginia coast, climatic and other conditions of the environment being likewise nearly identical, the following descriptions of the formations in Virginia may be regarded as in part supplemented in the paper cited:

The following is a synopsis of the formations and associations which are easily recognizable in the plant covering of the Dismal Swamp region:

- Maritime formations.
  - Salt-marsh formation.
    - Spartina stricta association.
    - Juncus roemerianus association.
    - Typha association.
    - Spartina patens association.
    - Baccharis-Hibiscus association.
  - Sand-strand formations.
    - Beach and outermost dunes—Ammophila-Uniola association.
    - Middle (open) dunes.
      - Dry soil—Myrica association.
      - Wet soil, dune marshes—Juncus dichotomus association.
    - Inner (wooded) dunes.
      - The high dunes—Quercus virginiana association.
      - The strand pine woods.

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[1] T. H. Kearney, Contributions from the National Herbarium, vol. 5, No. 5.

- Inland formations.
  - Nonhygrophile formations—The wooded or artificially deforested plain.
    - Forest formations.
      - Mixed forest.
      - Pine barrens.
    - Cleared-land formations (noncultural).
      - Arboreous (trees that have survived the forest).
      - Shrubby (thickets and hedges).
      - Herbaceous.
    - Cultural formations.
      - Field crops.
        - Garden vegetables.
        - Cereals.
        - Cotton.
        - Forage plants.
        - Other crops.
      - Cultivated trees.
        - Orchards.
        - Shade trees.
      - Weeds.
        - Cultivated land.
        - Waysides.
        - Ruderal plants.
  - Fresh-water formations.
    - Hygrophile forest.
      - Black gum swamp.
      - Open or light swamp.
        - Juniper forest association.
        - Ericaceae (shrubby) association.
        - Canebrake (Arundinaria) association.
        - Woodwardia-Sphagnum association.
    - Fresh-water marsh formations.
      - Reed-marsh formation.
        - Along rivers—Typha-Sagittaria association.
        - Edge hygrophile forest—Scirpus-Erianthus association.
      - Low marsh formation—Rynchospora-Eleocharis association.
    - Aquatic.

MARITIME FORMATIONS.

SALT-MARSH FORMATIONS.

What may be designated the "creek marsh" is a conspicuous element in the topography of the region. It occurs usually as a narrow strip bordering tidal streams up to the point where the water ceases to be brackish, but not infrequently covers wider areas in lagoons and bayous. The vegetation of the creek marsh is chiefly reed-like and very dense. The species composing it are halophile or salt-loving plants, most of which are only occasional in other situations. They are also limnophile, i. e., prefering a clay or mud bottom. Toward the upper limit of saline water the salt-marsh area becomes gradually narrower, and its species fewer, while plants characteristic of fresh-water marshes mix with the halophytic species, finally replacing them entirely. Thus, just above that point on the Nansemond River near Suffolk where the water begins to be normally fresh, *Spartina polystachya* and *Scirpus americanus* are the only remaining salt-marsh species, and such normally fresh-water plants as *Sagittaria lancifolia*, Pontederia, *Polygonum hydropiperoides*, *Typha latifolia*, and *Zizania aquatica* form the bulk of the association at the water's edge. It is probable that the last-named group of species can endure brackish water at times, while, on the other hand, as Contejean has shown,[1] most "salt-loving" plants are not really dependent upon the presence of salt in their substratum. It is probable that some salt-marsh species find the silty or clayey soil of the marshes, which is rich in organic matter, more indispensable than the sodium chloride which it contains.

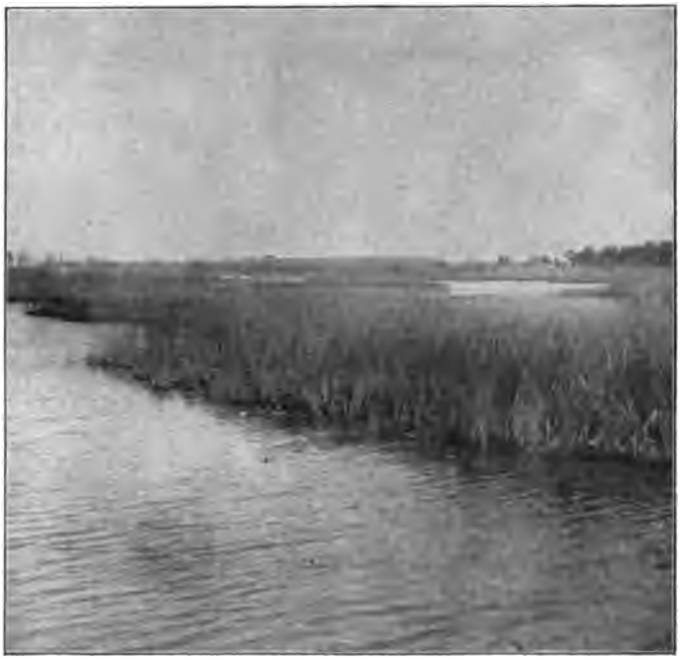

FIG. 57.—Salt marsh covered with *Spartina stricta maritima*.

Several associations of species, in each of which one species almost always strongly predominates, may be distinguished in the salt-marsh formation, although here as elsewhere sharp lines can rarely be drawn. The most important of these will be noted.

Spartina stricta association.—This assemblage, in which thatchy grass, *Spartina stricta maritima*, is often the only, and always by far the most important species, occupies the immediate edge of the water along creeks and estuaries, sometimes as a mere fringe, sometimes covering areas of considerable width (fig. 57). It prefers places

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[1] Géographie Botanique, p. 94.

covering wider areas than the Spartina and extending up to dry land. It is a plant which prefers situations that are not deeply inundated at high tide, and are left bare of superficial water, although saturated, when the tide goes out. Consequently, it is able to shelter a larger number of associates, and among its stems a majority of the salt-marsh species of the region find a congenial habitat.

Most abundant of these is the shrubby *Iva frutescens*, whose stems usually grow as high as or higher than those of *Juncus roemerianus*. Conspicuous in the autumn are the white rays of a slender, weak-stemmed, perennial Aster (*A. tenuifolius*). Less showy, but more abundant, is the usually stout annual *Aster subulatus*. *Lythrum lineare* and *Limonium carolinianum* are frequent. *Spartina patens* (a small form) and *S. polystachya* sometimes grow among the *Juncus*, and *Typha latifolia* frequently occurs in this association. At one point below Virginia Beach a somewhat peculiar assemblage of species occupies tiny pools among the Juncus growth—*Monniera* (*Herpestis*) *monniera*, *Lippia* sp. (with the leafy and flowering branches remarkably strict and slender), *Eleocharis mutata*, *Eleocharis glaucescens*, *Paspalum distichum*, etc.

Typha association.—The common cat-tail of the region is a not quite typical form of *T. latifolia*, which sometimes covers rather wide strips in nearly pure association, especially near the upper limit of brackish water along streams. Indeed, the same form is even more abundant in the fresh-water marshes, and appears to be to some extent indifferent to the presence or absence of considerable salt. It grows usually to a height of about 2 meters (6 feet).

Spartina patens association.—Very different in appearance from the other coarse-looking marsh grasses is a small, slender form of *Spartina patens* (*juncea*), which here and there forms a dense meadow-like, dark-green covering of the salt marsh, interrupting the *Juncus roemerianus* association. It is usually only 3 to 6 decimeters (1 to 2 feet) high. On Lynnhaven Bay and its branches, where this association appears to be most abundant, the grassy marsh is dotted in midsummer with the pink stars of *Sabbatia stellaris*. *Fimbristylis spadicea* occurs in some quantity, and occasional bushes of *Baccharis halimifolia* and clumps of *Panicum virgatum* vary the monotonous aspect of this association.

Other grass-like plants occasionally predominate in the salt-marsh vegetation, but are not of primary importance. *Scirpus americanus*, 6 decimeters (2 feet) or so high, sometimes forms a nearly pure association, conspicuous amid other marsh growth for its bright-green color. *Spartina polystachya*, not infrequent in other marsh associations, rarely forms small assemblages alone, for example, near the limit of navigation on the Nansemond River. It does not appear to grow so tall here as farther south, 1½ to 2 meters (5 to 7 feet) being its usual height. *Phragmites communis* is not uncommon near the heads of bayous, but rarely makes a dense growth to the exclusion of other species.

Baccharis-Hibiscus association.—A number of species are most at home in the wet soil at the inner edge of the salt marshes, whence they stray out into the *Juncus roemerianus* or other associations. Most important of these is *Baccharis halimifolia*, a handsome shrub usually 1½ to 2½ meters (5 to 8 feet) high. In the fall this plant is one of the showiest in the region, its snow-white pappus making a brilliant contrast to the dark-green foliage.[1] No less beautiful is *Hibiscus moscheutos* (locally, "wild cotton") with its large whitish or deep rose-colored flowers, a species very characteristic of the marsh borders. *Solidago sempervirens* is abundant. Only occasional in Virginia, although common farther south along the coast, is the sea ox-eye (*Borrichia frutescens*), an interesting, Helianthus-like composite, with straggling stems 3 to 6 decimeters (1 to 2 feet) long and thickish leaves, whose exceedingly dense covering of hairs gives a glistening appearance to the seemingly smooth surface. The large clumps of *Panicum virgatum*, "switch grass," are sometimes a conspicuous feature of the marsh borders. *Kosteletzkya virginica*, a malvaceous plant with showy rose-purple flowers, is frequent and characteristic. *Willughbaeya* (*Mikania*) *scandens*, *Rumex verticillatus*, *Pluchea camphorata*, and *Atriplex hastata* are less important.

The small marshes which occupy depressions among the sand dunes contain, as would be expected, some species that are normally salt-marsh plants. The greater part of their vegetation is composed, however, of fresh marsh and of sand-strand species. For convenience, they will be described under the head of "Sand-Strand."

The general aspect of the salt-marsh vegetation is somber and monotonous, despite the occasional presence of bright-colored flowers. This is due to the overwhelming predominance of a few species of reed-like and grass-like plants. Especially from autumn to early spring, when most of these are discolored and brownish, the color tone is a dull one.

ADAPTATIONS TO ENVIRONMENT IN THE SALT-MARSH VEGETATION—LIFE FORMS.

In regarding those conditions of the physical environment which most probably affect the structure and habit of salt-marsh plants, three points present themselves at once. These are:

1. Liability to partial submersion at high tide.
2. A soft, more or less mobile substratum.
3 The presence of a relatively high percentage of common salt (sodium chloride) in soil and water.

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[1] Although perhaps best developed at the edges of salt marshes, this plant is abundant in other situations, as along roadside ditches, sometimes at a considerable distance from salt water. It is also common among the dunes, in moist pine woods behind them, etc. It seems to be more dependent upon sea air than upon saline soil.

The modifications of structure which can be attributed with some degree of assurance to the action of these and other factors may be referred to three principal categories:

1. Structures preventing free access of water to submerged parts. The most striking adaptation of this class is the persistence of the basal sheaths in grasses and grass-like plants. This is beautifully exemplified in *Spartina stricta maritima*, the bases of whose culms are tightly enveloped by the closely imbricated, large papery sheaths.

2. Structures serving to hold the plant fast in the watery, incoherent soil. These take the form in most cases of long rootstocks, creeping through the mud and sending up erect leafy and flowering branches at frequent intervals. Of such character are the underground parts of the great majority of salt-marsh plants. Often, as in Typha, *Spartina polystachya*, Phragmites, and other large plants with a considerable weight to be supported, the rhizomes are very long and large. Annual plants, which are few in the salt marshes (*Aster subulatus* and *Salicornia herbacea* being the only common species), have less need of firm anchorage in the soil.

3. Structures serving to reduce the evaporation of water from the leaves, which would otherwise be excessive, as the chiefly herbaceous salt-marsh vegetation, unsheltered by large, woody plants, is directly exposed to the drying effect of the wind and to the strong light and heat of the sun. The necessity for such protection is the greater because, as is well known, roots absorb water with difficulty when it contains any considerable percentage of salts in solution, owing to the decreasing force of endosmosis when the degree of concentration of the external water approaches that of the cell sap. In order to compensate the reduced absorbing activity of the roots it is obvious that the escape of water from the upper part of the plant, especially from the leaves, where it is normally greatest, must be correspondingly checked.[1]

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[1] To the plants of the salt marshes, growing in a soil that is impregnated with salt (in solution) and subject to partial or total inundation twice a day by brackish water, it is of the utmost importance that the supply of water grudgingly yielded to them by the substratum should be guarded in every possible way. But even were it easier for salt-marsh plants to absorb water, it would not be to their benefit to take it up in great quantities, for this would result in an increased accumulation in the cells of sodium chloride, which would tend to exert a disturbing and even harmful influence upon the processes of assimilation and metabolism. Some plants endure the presence of greater quantities of salt than do others, but none can continue to live after a certain limit of accumulation has been reached. Even if salt-marsh plants can, as has been suggested (Diels, in Jahrb. f. Wiss. Bot., vol. 23, p. 316. For a criticism of Diels's experiments and conclusions, see W. Benecke, Jahrb. f. Wiss. Bot. 36, 179 to 196. 1901), decompose a considerable quantity of sodium chloride by means of the organic acids in their cells and reunite its elements into less harmful combinations, a limit to this process would soon be reached if the transpiration current were as unimpeded as in most plants of ordinary, moderately moist inland soils. Consequently the difficult absorption of water, which is usually regarded as an adverse condition, would appear to be positively beneficial in the case of salt-marsh plants.

Among modifications that are probably effective in diminishing transpiration may be cited:

(*a*) Thickening of the cuticle and epidermis walls, which is exhibited, often to a high degree, by nearly all plants of the salt marsh. This thickening is often conspicuous when species of the salt marsh are compared with nearly related species from other localities, or even when individuals of the same species, respectively inhabiting the salt marsh and some other habitat, are placed side by side. A more or less pronounced roughening of the cuticle is also frequently to be detected. Its probable service to the plant will be discussed presently.[1]

(*b*) Hairy covering sufficiently dense to be of service as a protection against excessive transpiration occurs only in *Borrichia frutescens*, which has both leaf surfaces very densely covered with two to four celled hairs (each epidermis cell being thus extended by tangential division); on the under leaf surface of *Hibiscus moscheutos*, and possibly on the stellate-pubescent leaves of *Kosteletzkya virginica*, in which species, however, the hairiness is far less dense.

(*c*) Stomata, protected by being situated in furrows of the leaf surface, which are in some cases partially closed by hairs, in species of Spartina, etc.; and correlated with this—

(*d*) Leaf becoming conduplicate or involute, thus concealing the ventral surface, where all or most of the stomata lie, especially in the species of Spartina and in certain sedges.

(*e*) Leaf vertical in *Juncus roemerianus*, *Fimbristylis spadicea*, and *Typha latifolia*; nearly vertical in species of Spartina and other grasses, and in Baccharis, *Aster* spp., *Iva frutescens*, and other dicotyledons with isolateral leaves.

(*f*) Transference of the normal functions of leaves in large part to the (erect) stems, in *Juncus roemerianus*, *Scirpus americanus*, and *Salicornia herbacea*.

(*g*) Small size of the leaves, and hence of the transpiring surface, without transfer of function to the stems, in *Aster subulatus*, *Aster tenuifolius*, *Sabbatia gracilis*, *Lythrum lineare*, *Lippia* sp., *Monniera* (*Herpestis*) *monniera*, and many other species.

(*h*) Succulency: of stem (accompanied by reduction of the leaves to mere scales), *Salicornia herbacea*; of leaves (moderate), Borrichia, *Solidago sempervirens*, *Aster* spp. (in *A. subulatus* the stems are also somewhat succulent). Succulent plants lose their water much more slowly than do others, since the water tissue, the strong development of which causes the thickening of the succulent parts, gives up its supply reluctantly. This is in some cases due to the presence of a mucilaginous slime in the cells of the water tissue, which greedily absorbs and tenaciously retains much water.[1]

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[1] Page 389.

(*i*) Presence of a considerable quantity of mineral salts, especially sodium chloride, in solution in the cell sap. It is well known that the rapidity of evaporation from a given liquid surface decreases in proportion to the density of the liquid. Consequently a plant organ which holds in its cells more than the ordinary quantity of dissolved mineral substances loses by transpiration less than the ordinary amount of vapor of water. We have here another instance of the fact that while the presence of much salt in the soil is generally regarded as a circumstance wholly adverse to plant life, certain species are able to use this substance in such a way as to neutralize its own injurious action.

(*j*) Development of compact palisade tissue, usually on both surfaces of the (in such cases) isolateral leaf, in nearly all the species.

4. Adaptations to exposure to the mechanical action of the wind. The most noteworthy are (a) the prevailing biological form, i. e., the grass-like, which offer little resistance; and (b) the development of considerable mechanical tissue, notably in the grass-like monocotyledons, where this sometimes takes the form of strong peripheral groups of stereome (i. e., in the stem and leaves of *Juncus roemerianus*).

Specialized modifications for dissemination of the seeds are not numerous in the salt-marsh plants. The glumes of species of Spartina appear to be fitted to some extent to float upon the water, as is the fruiting calyx of Salicornia, with its spongy thickening. The bristles of Typha, the callus hairs of Phragmites, and the bristly pappus of the Asters, Solidago, and Baccharis, are of course adapted to carriage by the wind. Burs, winged fruits, and edible fruits appear to be almost entirely wanting.

SAND-STRAND FORMATIONS.

In Virginia, as in other parts of the world, the well-marked topographical division known as the sand strand is occupied by a sparse vegetation, in open formation, i. e., the individual plants mostly grow far enough apart to leave much of the soil visible among them. For this reason the strand sand contains an unusually small amount of underground parts of plants, and is consequently the more easily blown about by the wind. In the Dismal Swamp region this formation comprises three rather clearly defined belts. These are: (1) the beach and low outer dunes, bearing a particularly sparse, almost entirely herbaceous, growth, composed of very few species; (2) the higher middle dunes (white dunes or sea dunes), with their summits often crowned with small thickets, and with a more abundant and diversified herbaceous vegetation, especially in the depressions among them; and (3) the innermost, highest dunes (gray or land dunes), which are almost always covered with pine forest.[1] In the third belt may best be included the flat, dry pine woods that almost always occur immediately behind the dunes.

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[1] Compare Volkens, Flora der Ägyptisch-Arabischen Wüste, p. 43, 1887. It has been suggested (Massart, Mém. Soc. Roy. Bot. de Belgique, 32, pt. 1, pp. 18, 19. 1893.) that the frequency of succulent plants among the salt-marsh vegetation is due to the fact that such plants obtain most of their water, not when the soil is covered with salt water at high tide, but when rain falls during the ebb. If this could be demonstrated, the necessity for tissue adapted to holding water for considerable and indefinite periods would be evident.

BEACH AND OUTER DUNES.

The outermost line of dunes is usually only 2 meters or so above high tide, and the sloping beach between it and the water is commonly devoid of plant growth, although often strewn with sea wrack (*Zostera marina*) which has been cast up by the waves. Sometimes, however, a few plants of sea rocket (*Cakile edentula*) and of saltwort (*Salsola kali*) are found here. Rarely *Ammodenia* (*Honkenya*) *peploides* occurs. The beach is the area characteristically occupied in the Tropics by the Pes-caprae formation, which is composed of such plants as *Ipomoea pes-caprae* and *Spinifex squarrosus*.[2]

The outer line of dunes, usually less than breast-high and constantly shifting, is inhabited by certain hardy, strong-rooting plants, which send up numerous stems from their branching root stocks. Marram grass (*Ammophila arenaria*), growing usually to a height of about 6 decimeters (2 feet), is the most abundant of these (fig. 59), but not rarely gives place to small colonies of the handsome sea oats (*Uniola paniculata*) (commonly 6 to 9 decimeters, 2 to 3 feet, high), which entirely replaces Ammophila not far south of this region (fig. 60). An aromatic composite, *Iva imbricata*, forms roundish clumps of stout, nearly erect stems (usually about 6 decimeters, 2 feet, high), and is the only noteworthy bright green plant of the outermost dunes (fig. 61).

Another grass similar in habit to *Uniola paniculata* is *Panicum amarum minus*, which is not uncommon on the outermost dunes. Its strong, widely branching rhizomes send up numerous leafy branches, but few that bear flowers. In this respect, also, it resembles Uniola and Ammophila. Each of these three grasses seems generally to grow only where the others are absent. It is not uncommon to see one small dune held by Ammophila alone and its nearest neighbor bearing only Uniola or Panicum.

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[1] At Cape Henry the very high innermost dunes are not forested, and are almost entirely bare of vegetation, the only growth being a few plants of *Ammophila arenaria*.

[2] See Schimper, Indomalayische Strandflora, pp. 77 to 84. See also p. 385 below.

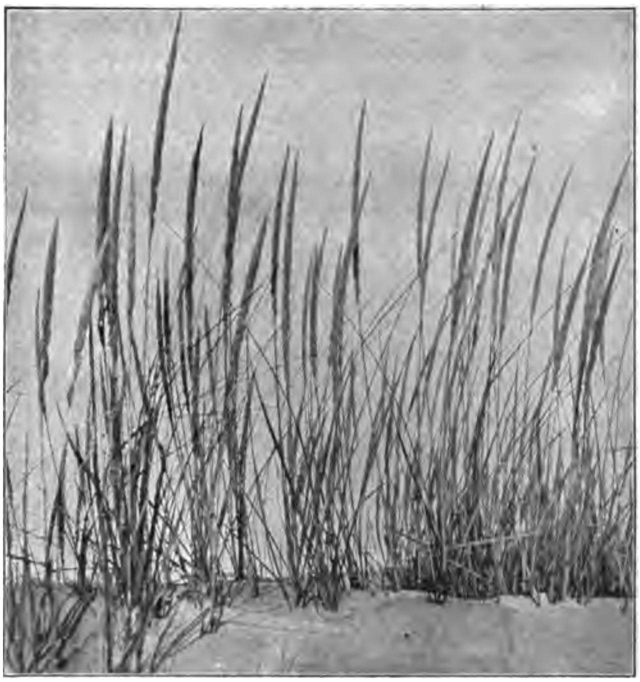

FIG. 59.—Marram grass (*Ammophila arenaria*) on the dunes near Cape Henry, Va.

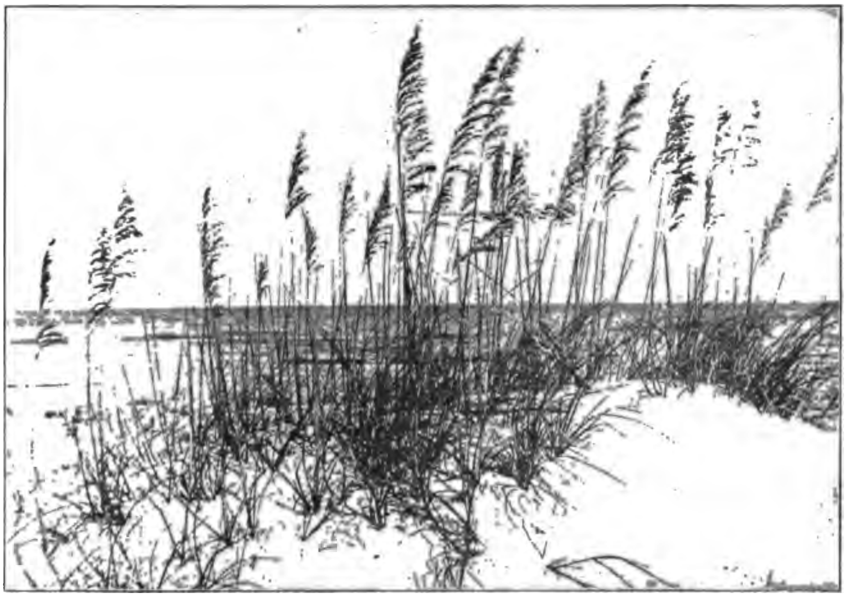

FIG. 60.—Sea oats (*Uniola paniculata*) on the dunes near Cape Henry, Va.

Cakile edentula and *Salsola kali*, both succulent annuals, attain their best development on the exterior line of dunes. The former, especially, sometimes forms large mats, with decumbent branches as much as 9 decimeters (3 feet) long and a strong taproot penetrating vertically into the sand to a maximum depth of 2 feet (6 decimeters). A stout, low-stemmed Xanthium[1] was observed only at Cape Henry, where it formed part of this association. *Oenothera humifusa*, *Euphorbia polygonifolia*, *Cenchrus tribuloides macrocephalus*, *Mollugo verticillata*, and other species which are most at home in the second belt sometimes stray to the outermost dunes. Depauperate specimens of *Myrica carolinensis*, only 3 decimeters (1 foot) or so high, sometimes occur here, as do occasional specimens of other woody plants. But these are to be regarded as, in a way, accidental cases.

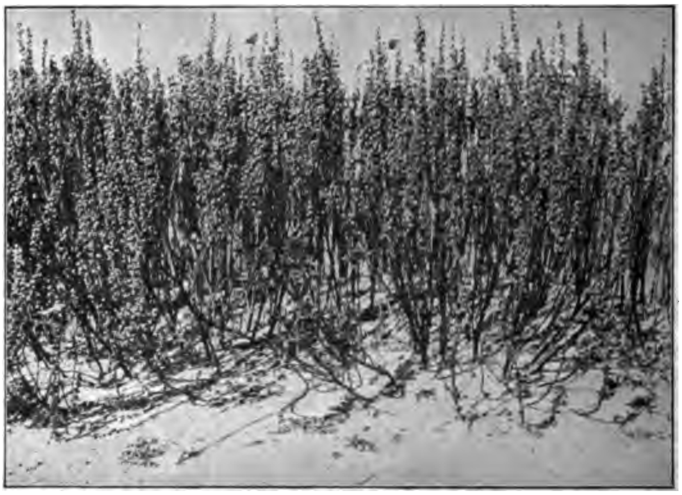

FIG. 61.—*Iva imbricata* on the dunes near Cape Henry, Va.

MIDDLE (OPEN) DUNES.

Myrica association. Here *Cakile edentula* and *Salsola kali* frequently occur, but are not characteristic. *Uniola paniculata* and *Iva imbricata* are absent, while, on the other hand, *Ammophila arenaria* and *Panicum amarum minus* are almost or quite as much at home as on the outermost dunes (fig. 62). In sheltered, flat places Ammophila sometimes makes a comparatively dense, almost meadow-like growth, often associated with scattered depauperate shrubs—*Myrica carolinensis*, *Quercus virginiana maritima*, *Rhus copallina* (fig. 63). The higher sand hills are often occupied by dense thickets of *Myrica*

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[1] Apparently an undescribed species, nearest the European *X. italicum* Murr.

carolinensis, usually 1½ to 2 meters (5 or 6 feet), but frequently 3 meters (9 feet), high, often unaccompanied by other woody species (fig. 64). This plant, which is more or less at home in the drier portions of the forested plain, is, however, most characteristic as a dune plant, and is noteworthy as the shrub which usually occurs nearest the beach.

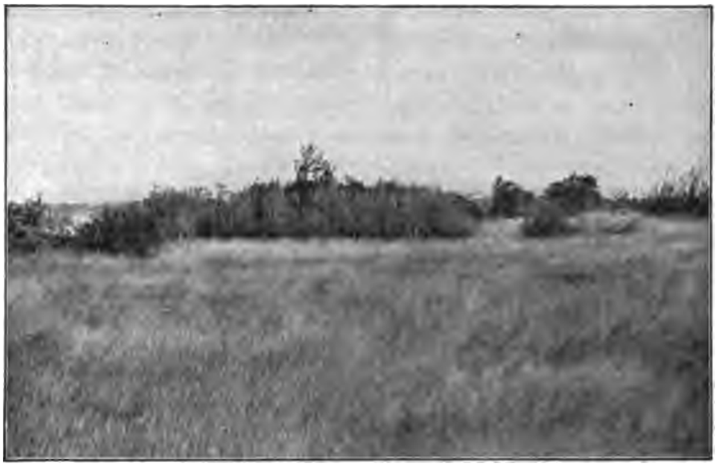

FIG. 62.—Meadow-like growth of Ammophila near Oceanview, Va.

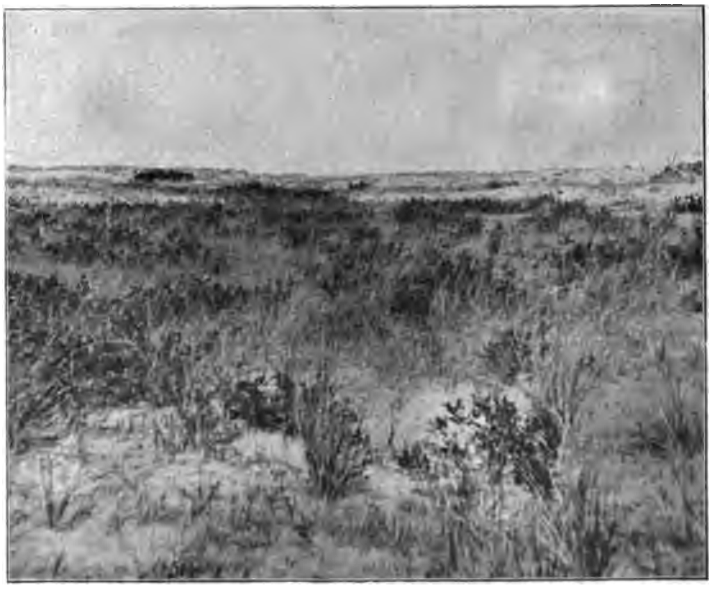

FIG. 63.—Ammophila with *Myrica carolinensis* at Cape Henry, Va.

carolinensis, usually 1½ to 2 meters (5 or 6 feet), but frequently 3 meters (9 feet), high, often unaccompanied by other woody species (fig. 64). This plant, which is more or less at home in the drier portions of the forested plain, is, however, most characteristic as a dune plant, and is noteworthy as the shrub which usually occurs nearest the beach.

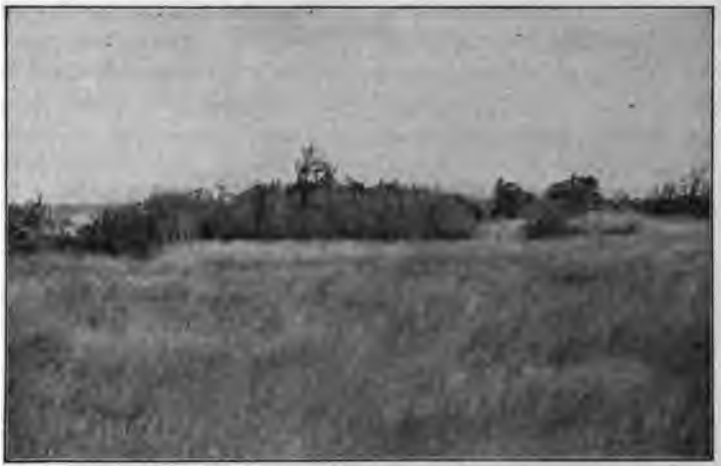

FIG. 62.—Meadow-like growth of Ammophila near Oceanview, Va.

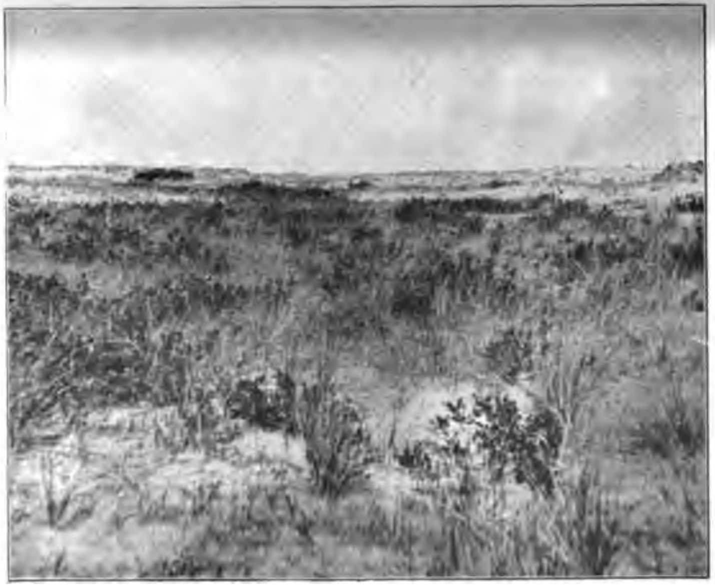

FIG. 63.—Ammophila with *Myrica carolinensis* at Cape Henry, Va.

usually strongly inclined landward—an evidence of the force of the winds. *Baccharis halimifolia* on the dunes usually grows at the edge of the Myrica thickets.

While the open dunes are not forested, scattered small trees often grow upon or among them. Most frequent, and usually advancing farthest toward the beach, is the loblolly pine (*Pinus taeda*), which here sometimes attains a height of 13 meters (45 feet) and a diameter of 7 or 8 decimeters (2½ feet) (fig. 66). Other species that attain the dignity of trees are the black cherry (*Prunus serotina*), with its leaves thicker than is normally the case inland; the persimmon (*Diospyros virginiana*), which ripens fruit abundantly; the Spanish oak (*Quercus digitata*), and rarely the holly (*Ilex opaca*). All show the effect of the wind in the position of their trunks, which lean in a landward direction, their numerous dead branches (especially upon the windward side), and the position of their ragged crown of foliage (almost altogether on the leeward side of the stem).

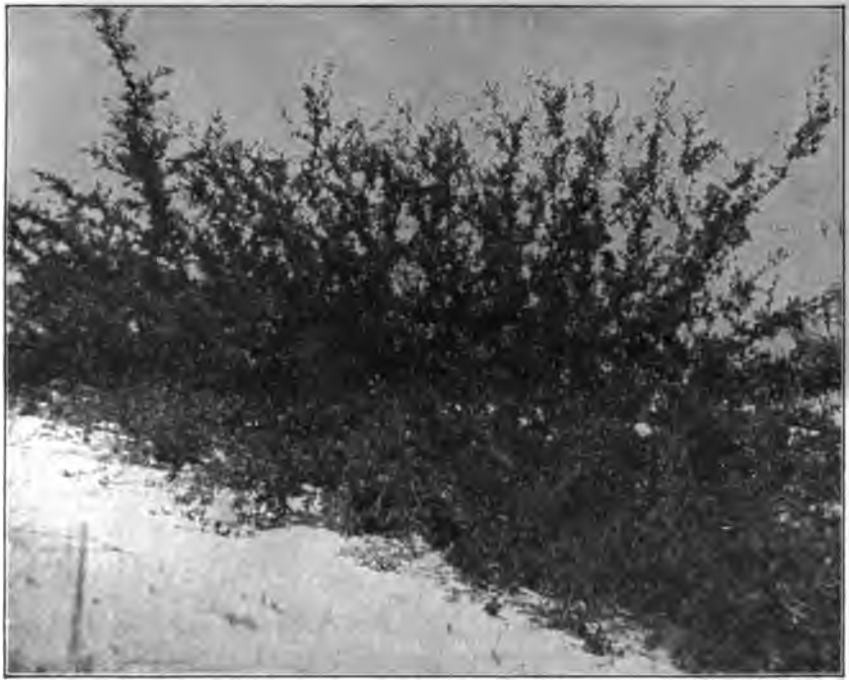

FIG. 65. Live oak (*Quercus virginiana*) on the middle dunes near Oceanview, Va.

A striking characteristic of the middle-dune vegetation, as of nearly all plant formations of the southern coastal plain, is the strong development of woody lianas or climbing plants. These either support themselves upon the shrubs, especially in the Myrica thickets, where they often form almost impenetrable tangles (comparable to the able size, usually about a meter (3 feet) high (fig. 68). The somewhat one-sided panicles bend in a graceful manner. The large form of *Spartina patens* (*juncea*) sometimes grows on and among the dunes.

The other predominant herbaceous plants are mostly small, and are best developed in the depressions and on the sides of the dunes. Short-rooted annual or biennial species, with prostrate stems forming mats, such as *Oenothera humifusa*, *Euphorbia polygonifolia*, *Triplasis purpurea*, *Mollugo verticillata*, and *Diodia teres*, are abundant, the last attaining an unusual size. Depauperate *Linaria canadensis* (mostly 8 to 12 centimeters (3 to 5 inches) high) is conspicuous in spring with its bright blue flowers, but disappears by midsummer. It is probably a winter annual.[1] *Gnaphalium purpureum*, a biennial species, is not

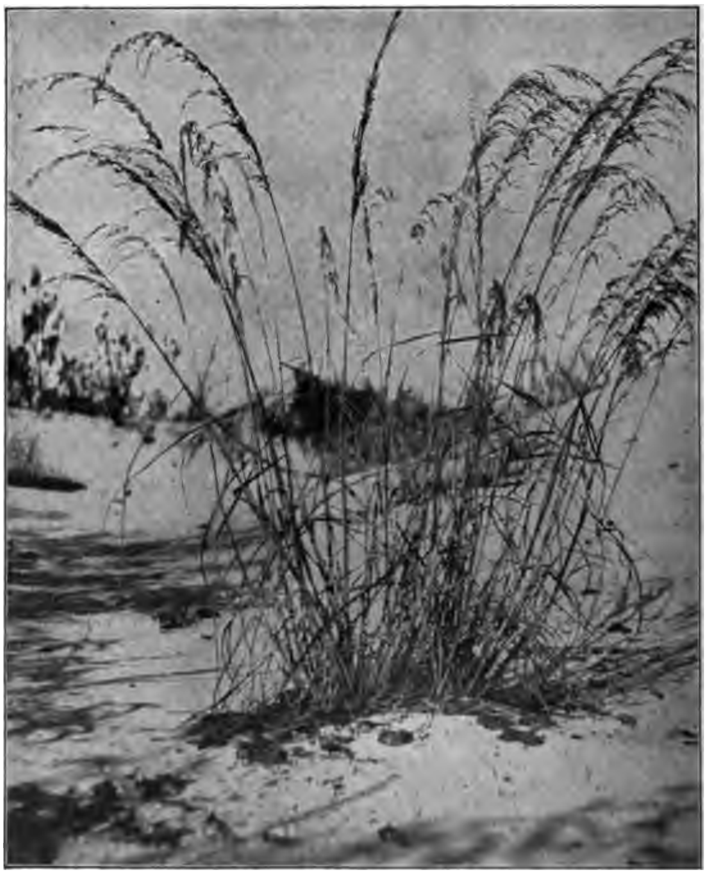

Fig. 68.—*Panicum amarum* among the dunes near Oceanview, Va.

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[1] The small size and early maturity of this species is what would be expected from its lack of special adaptations to the strand environment. It is in this respect similar to many annuals of the deserts, as described by Volkens (Flora der ägypt-arab. Wusten, pp. 20, 40) and Coville (Contr. U. S. Natl. Herb. 4:44, 45).

uncommon. A reduced form of the annual *Erigeron canadensis*, sometimes only 5 to 8 centimeters (2 or 3 inches) high, and with thicker leaves than in other situations, is especially abundant in rather moist sand. *Lechea maritima* and *Hudsonia tomentosa* (both perennial and suffrutescent) usually grow together, but the latter often covers small areas unassociated with other species (fig. 69). A small Cyperus with hard tubers, *C. grayi*, and two or three species of Panicum (*P. scribnerianum*, *P. angustifolium*) often grow with these Cistaceae, the first, however, sometimes in pure associations. *Phaseolus helvolus*, with long, radiant, prostrate stems, is occasional in open places.

Monarda punctata is abundant, particularly at the edge of the Myrica thickets, where *Cenchrus tribuloides macrocephalus*, a canescent form of *Solanum nigrum*, and *Physalis viscosa*[1] are most at home. In the shelter of the bushes of *Myrica carolinensis* a number of species occur which do not properly belong to the dune flora and are not especially adapted to that environment. Such are *Phytolacca decandra*, typical *Erigeron canadensis*, *Eupatorium capillifolium* (*foeniculaceum*), and *Chenopodium anthelminticum*, the last, however, not rarely occurring away from the shade and protection of the thickets. These plants wilt much more rapidly when uprooted than do most of the true dune plants.

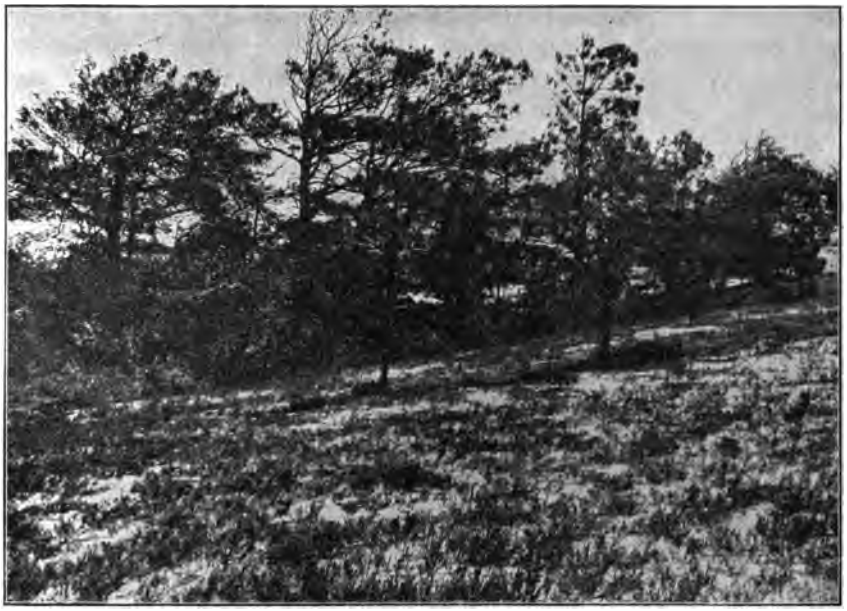

FIG. 69.—*Hudsonia tomentosa* on the dunes near Virginia Beach (*Pinus taeda* in background).

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[1] This plant, which was seen in Virginia only at Cape Henry, is common along the North Carolina coast.

The dune marshes.—In small, nearly level tracts or basin-like depressions among the dunes, with a subsoil denser than the surface sand, rain water is often held for days, forming shallow pools; and here the soil, even at the surface, is normally wet. In such places a marsh vegetation finds opportunity for development, and contrasts with other vegetation of the open dunes in that it grows densely, or, in other words, in closed formation. The prevailing species are mostly not halophile plants, although *Scirpus americanus* and *Fimbristylis spadicea* are often abundant. On the other hand, species normally not halophile, especially two rushes, *Juncus scirpoides* and *J. dichotomus*, usually dominate the association and give a dull brown color to the whole. *Panicum virgatum* and *Andropogon glomeratus* are not infrequent. In the wet sand at the edges depauperate *Erigeron canadensis* (with thickish leaves), diminutive *Sarothra gentianoides*, and *Diodia virginiana* usually occur. Depauperate Myrica bushes frequently occur sparsely.

Sometimes, as in a marsh at Cape Henry, a considerable variety of inland palustrine species associate together, notably *Eragrostis refracta*, *Lycopodium inundatum*, *Drosera intermedia*, *Fimbristylis autumnalis*, *Rynchospora cymosa*, *Centella asiatica*, *Hydrocotyle umbellata*, etc. South of Virginia Beach a similar marsh contained, in addition to these, *Rhexia mariana*, *Eupatorium rotundifolium*, *Cyperus haspan*, *Panicum sphagnicola*, *P. agrostoides*, and cranberry (*Oxycoccus macrocarpus*), the last with stems 2 meters (nearly 7 feet) long, creeping among and almost hidden by other plants.

Such marshes are really part of the fresh-water vegetation of the region, but are placed here for the sake of topographical continuity, and because of the occurrence in them of a few halophile or hemihalophile species. They form a transition from the sand strand to the salt marsh on the one hand and to the low fresh-water marshes on the other. They may well be termed "neutral ground."[1]

THE INNER (WOODED) DUNES.

The high dunes.—These are usually the highest of the dunes, and in most cases bear an open forest of small short-leaf pine (*Pinus taeda*), usually 6 to 9 meters (20 to 30 feet) high and 3 decimeters (1 foot) or less in diameter. Sometimes a small growth of deciduous trees and shrubs, notably black cherry (*Prunus serotina*),[2] persimmon (*Diospyros virginiana*), *Xanthoxylum clava-herculis* (sometimes 6 meters, 20 feet, high), *Sassafras sassafras*, *Juniperus virginiana*, etc., mingle with or take the place of the pine. At Cape Henry occur thickets of laurel oak (*Quercus laurifolia*), mostly 3 to 3½ meters (10 to 12 feet) high.

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[1] Massart describes the vegetation of dune marshes along the Belgian coast as "in all things similar to that which inhabits marshes in the interior of the country." Mém. Soc. Roy. Bot. de Belgique, vol. 32, p. 10 (1893). For a reproduction of a photograph of one of these marshes see the same author (loc. cit., pl. 1).

[2] The largest specimen observed was about 9 meters (30 feet) high and 3 decimeters (1 foot) in diameter.

The ground being shaded and protected from the wind by the trees, a small amount of humus collects on the surface of the inner dunes, giving the soil a gray color (hence "gray dunes," one of the terms by which they are known in Europe).[1] Here, among the pines, the live oak (*Quercus virginiana*) attains its best development on the Virginia coast, although in this region it is never of arboreous size and shape. *Quercus virginiana* assumes on the wooded dunes a compact, rounded, symmetrical form, with nearly horizontal branches, very different from its aspect among the open dunes. The largest specimen seen was about 8 meters (25 feet) high, about 8 meters in greatest spread of branches, and the diameter of the largest stem 3 decimeters (1 foot) above the ground was nearly 6 decimeters. The live oak grows scatteringly among the pines, not forming thickets. In the dull, dark color of its foliage it resembles *Myrica carolinensis*.

On the summit and outer slope of the fixed dunes *Ammophila arenaria* is still abundant, sometimes carpeting the ground to the exclusion of other herbaceous vegetation; but apparently flowers are rarely if ever produced in this situation. Doubtless it was this grass which contributed most to the original fixing of these dunes and their preparation for other vegetation; and one might fancy that the plant is reluctant to yield its sway to less hardy species. *Panicum amarum minus* and *Cyperus grayi* are common on the fixed dunes. With the latter *C. cylindricus*, of similar habit, frequently occurs. But the most characteristic herb of these dunes is *Galium hispidulum*, which has slender yellow rootstocks branching and creeping through the sand in every direction at a depth of usually 2 to 4 centimeters (1 or 2 inches), while sending up at frequent intervals clusters of leafy and flowering stems, commonly only 8 or 10 centimeters (3 or 4 inches) high.

Quite different is the type of vegetation normally occupying only the inner slope of the forested dunes, but occasionally extending over the crest and down the outer slope. Here prevails a dense low undergrowth of chiefly woody species, some of which do not venture farther into the strand formation. In a typical place *Sassafras sassafras* and *Xanthoxylum clava-herculis*, the latter attaining here a height of only 3 to 6 decimeters (1 to 2 feet), were particularly abundant. *Smilax bona-nox*, *S. glauca*, *Vitis aestivalis*, *Tecoma radicans*, and *Parthenocissus quinquefolia* formed dense tangles among the low shrubs. At other points *Ilex opaca*, *Rubus cuneifolius*, *Aralia spinosa*, *Callicarpa americana*, and even *Acer rubrum* and *Nyssa sylvatica*, enter into this association.

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[1] Warming, Ökologische Pflanzengeographie, p. 243.

The strand pine woods.—Many of the species just enumerated form the chief undergrowth of the dry, flat pine woods, which often border the dune area on its inner side (figs. 70, 71). They form the transition to the forested plain beyond, but can be more conveniently classed with the fixed dunes. The principal tree is loblolly pine (*Pinus taeda*). *Aralia spinosa* (1 to 3 meters, 3 to 10 feet, high), *Xanthoxylum clava-herculis* (attaining a height of 6 meters, 20 feet), and *Callicarpa americana* are more characteristic of this formation than of any other in the region. *Gelsemium sempervirens*, *Tecoma radicans*, and other lianas are abundant, Tecoma in places ascending the trunks of all the small pine trees, and giving to such areas a peculiar and striking appearance. Where the strand forest is somewhat moist, *Baccharis halimifolia* is often the principal element of the undergrowth. In very dry soil, in openings among the trees, sand blackberry (*Rubus cuneifolius*), starved specimens of black locust (*Robinia pseudacacia*), and Chickasaw plum (*Prunus angustifolia*) sometimes form small, low thickets.

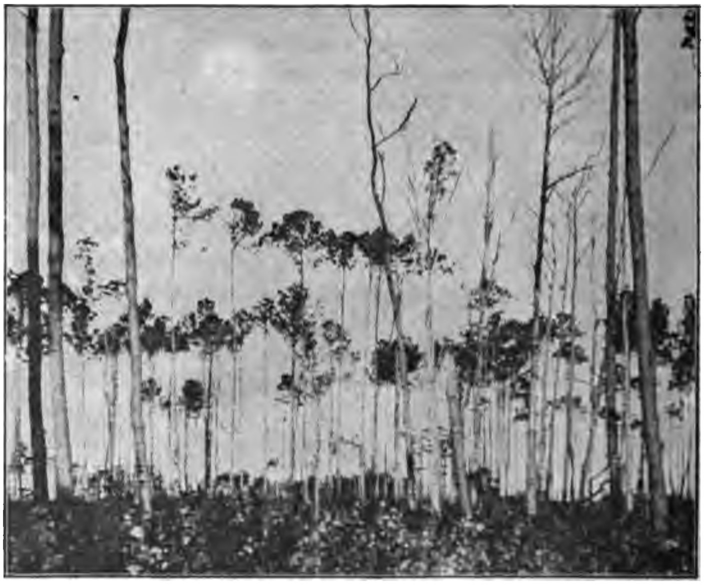

FIG. 70. Strand pine woods at Oceanview, Va.

The herbaceous species that occur in this association are chiefly such as characterize the drier parts of the inland forest generally. *Opuntia opuntia* and *Yucca filamentosa*, however, appear to be more at home here than elsewhere. Compositae (species of Solidago, Eupatorium, Elephantopus, Erechtites, and Chrysopsis), Leguminosae (species of Meibomia (Desmodium) and Lespedeza), *Danthonia sericea*, *Uniola laxa* (*gracilis*), and *Convolvulus americanus* are worthy of mention. In somewhat boggy soil occur *Galium claytoni*, *Panicum ciliatum*, *Polytrichum commune*, and small quantities of peat moss (forms of *Sphagnum cymbifolium* and *S. recurvum*, occasionally *S. henryanum*). In one diminutive sphagnum bog the moss, both living and dead, was only 20 to 25 centimeters (8 to 10 inches) high. The surface had, at noonday, absorbed much heat from the sun and was perfectly dry, while the lower part was wet and quite cold. The substratum was the prevailing sand.

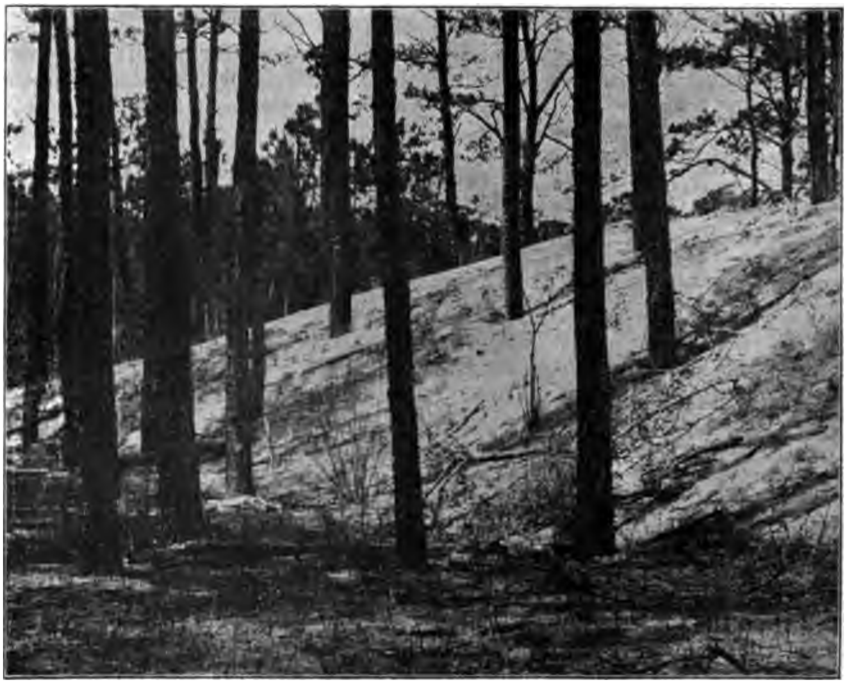

FIG. 71.—Innermost dunes encroaching on the strand pine woods (of *Pinus taeda*) near Virginia Beach.

SAND STRAND OF LYNNHAVEN BAY.

The Sand Strand of Lynnhaven Bay and its ramifications is less exposed to the wind than the shores of the Chesapeake and the open Atlantic, and is therefore without typical dunes. Its plant associations are somewhat different from those of the outer Sand Strand, containing, as would be expected, a larger admixture of inland forms. The narrow strip of beach lies in most places in front of an abrupt bank, which is often 3 to 5 meters (10 or 15 feet) high. The summit of this bank is commonly covered with trees, and it forms the edge of the inland forest, but shelters a plant association somewhat different from any other in the region. The prevailing pine is often *Pinus echinata*, which attains a better development here than elsewhere in the region, being frequently 18 meters (60 feet) high and 8 decimeters (2½ feet) in diameter near the base. At other points *Pinus taeda* predominates. Other characteristic trees are *Quercus minor*, which grows to a considerable size, and a small growth of *Q. digitata*, *Diospyros virginiana*, and *Hicoria glabra*.

Myrica carolinensis, *Rhus copallina*, *Symplocos tinctoria*, *Persea pubescens*, and *Quercus digitata* form in places small dense thickets at the foot of the bank. Spanish moss (*Tillandsia usneoides*), with stems sometimes a meter (nearly 4 feet) long, drapes the branches of oaks and pines, especially *P. echinata*. Of lianas, *Smilax bona-nox*, *Tecoma radicans*, and *Rhus radicans* are most common. In the flat, open pine groves, which occasionally occur at the foot of this bank just above high tide, red fescue grass (*Festuca rubra*) forms a somewhat dense sod, with scattered symmetrical clumps of *Panicum virgatum* and considerable numbers of *Yucca filamentosa* and *Opuntia opuntia*. In the pine woods at the summit of the bluff woody undergrowth is often scarce, and there occurs a scanty herbaceous growth comprising *Tragia urens*, *Jatropha stimulosa*, *Meibomia* (*Desmodium*) *stricta*, *Sporobolus asper*, *Chrysopsis graminifolia*, *Galium hispidulum* (abundant), *Uniola longifolia*, *Helianthemum canadense*, and species of Panicum (of the *dichotomum* type). In some places *Rubus trivialis*, with trailing stems, is abundant.

On the narrow strip of sandy beach and the open face of the bluff above it two Leguminosae, in habit similar to *Rubus trivialis*, occur. These are *Phaseolus helvolus* and *Bradburya* (*Centrosema*) *virginiana*, the latter with numerous large, showy, lilac-colored flowers. The principal branches of their stems lie flat upon the ground, radiating in every direction, but do not attach themselves to the soil by roots at the nodes. The longest branches observed measured 15 decimeters (Phaseolus) and 18 decimeters (Bradburya). Both are twining plants when able to find supporting objects. *Festuca rubra* is occasional on the beach. Other plants of this strand are common species of the outer beach—Ammophila, *Panicum amarum*, *P. amarum minus*, *Salsola kali*, *Cakile edentula*, *Hudsonia tomentosa*, *Lechea maritima*, *Spartina patens* (*juncea*), *Cenchrus tribuloides macrocephalus*, etc.

Of the plants mentioned as occurring among the dunes, the following are strand species in the strictest sense, seldom or never entering into any other formation:

Ammophila arenaria,
Uniola paniculata,
Panicum amarum,
P. amarum minus,
Spartina patens (the large form),
Cenchrus tribuloides macrocephalus,
Cyperus grayi,
Quercus virginiana (*virens*),[1]
Ammodenia (*Honkenya*) *peploides*.
Cakile edentula,
Euphorbia polygonifolia,
Lechea maritima,
Hudsonia tomentosa,
Oenothera humifusa,
Physalis viscosa,
Galium hispidulum,
Diodia teres,[2]
Iva imbricata.

Other species which occur on the strand reach their best development farther inland. It will be observed that the percentage of such inland plants is comparatively small seaward from the crest of the fixed dunes.

ADAPTATIONS TO ENVIRONMENT IN THE STRAND VEGETATION—LIFE FORMS.

Under the headings of climate, topography, and soils of the Dismal Swamp region, the various factors that constitute the physical environment of the strand vegetation were discussed in a very general way. Of these factors, the most important in their effect upon plant growth are probably to be referred to two categories. To the first belong the movements of the atmosphere, so far as their mechanical effects upon the vegetation are concerned, whether direct, or indirect, i. e., through their action upon the substratum. The second comprises all such factors as tend to bring about excessive transpiration, and consequently necessitate protective modifications.

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[1] Almost always a strand plant in Virginia and North Carolina.

[2] Rare, except as a strand plant, in the Dismal Swamp region.

MODIFICATIONS DUE TO THE MECHANICAL ACTION OF THE WIND.

Exposure to frequent strong winds laden with fine particles of sand is the more or less probable cause of certain modifications in the vegetation, especially that of the open dunes. Three principal results of such exposure may be mentioned:

Direct effect on the external form of the plant.—This is evident in individual trees and large shrubs of the open dunes, which are marked by their trunks usually leaning in a direction opposite to that of the prevailing winds, the branches on the wind-exposed side being often entirely denuded, leaving the crown of foliage to leeward of the trunk; by their gnarled and twisted stems and branches, the latter often rigid and comparatively short; and frequently by their torn and ragged-looking foliage (especially in such inland species as *Platanus occidentalis* and *Taxodium distichum*, when straying into this area).

Indirect or histological effect.—This often appears in the development of much strengthening tissue (stereome, wood), and in a considerable thickening of the cuticle and epidermis cell walls of the leaves, giving the surface a hard, resistant, polished texture. The latter is especially notable in the evergreen leaves of *Quercus virginiana*, and in the whole surface of the larger grass-like plants, *Uniola paniculata*, *Ammophila arenaria*, *Panicum amarum*, etc. It is a modification chiefly important to the plant as a protection against excess of light and of transpiration, but is perhaps also useful as a protection against the impact of strong, sand-laden winds.[1]

Effect through redistribution of soil.—The wind blowing upon the incoherent surface soil keeps it in almost constant motion, and often shifts great masses of it in a short time. Consequently some plants are being uprooted, while others are quickly buried beneath the sand. This action is, of course, most violent in winter. Large dunes that have been cut open by the wind exhibit dead roots and rootstocks (of Smilax, Ammophila, etc.) far below the surface. To the necessity of adapting themselves to the mobile soil in cooperation with other factors are due some of the interesting life forms which strand plants exhibit. The most notable of these are:

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[1] How strongly the wind may act upon plants not protected in some such way is evident in the tattered older leaves of the banana, which usually become segmented by the splitting through to the midribs of the tissues between the parallel lateral nerves.

1. Long, branching rootstocks, which send up numerous leafy or flowering branches. These are either slender and creep near the surface of the sand, as in Ammophila,[1] *Galium hispidulum* (longest more than 9 decimeters—3 feet), and *Scirpus americanus*, which last grows in moist sand and has rootstocks usually rather stouter than those of the others; or the rhizomes are stout and descend obliquely or almost vertically deep into the sand, as in *Uniola paniculata* (one rootstock was actually traced 6 decimeters (2 feet), and was probably a meter or more in length), *Panicum amarum*,[2] and *Iva imbricata*, which has rootstocks at least 9 decimeters (3 feet) long.

Physalis viscosa resembles *Galium hispidulum* in habit, but in this case it is from slender branched roots, having a maximum length of over 12 decimeters (4 feet), that the low, leafy, and flowering shoots originate. Such habit of growth is immensely serviceable to strand plants, as it goes far toward securing them from being uprooted, and likewise protects them from burial by the sand. For, while by an occasional movement of the sands the above-ground stems may be completely overwhelmed, the subterranean parts continue to grow forward and to send up new branches, which unfold leaves and flowers.[3] The more deeply penetrating rootstocks are also useful to the plant by insuring it a constant supply of water.

Shrubs and small trees among the dunes often develop greatly elongated roots, although these are not to be compared in length with the roots, enormously extended in proportion to the stem length, that have been detected in many desert plants.[4] This was particularly observed in *Pinus taeda*, of which small specimens showed a stem less than 1 meter (3 feet) high, but had roots at least 5 meters (over 16 feet) long. An individual of *Xanthoxylum clava-herculis* was even more remarkable, having a stem less than three decimeters (1 foot) and roots 4½ meters (15 feet) long.

2. Stems trailing over the ground, but usually not attached to it by

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[1] The longest rootstock of this grass which was examined measured 3 meters (10 feet), while the thread-like, much-branched roots are sometimes considerably over a meter (4 feet) long. In other localities a much greater extension of the rootstock has been observed.

[2] In *Uniola paniculata* and *Panicum amarum* the roots, as well as the rootstocks, are stouter than those of Ammophila.

[3] "The species of the genera Agropyrum and Ammophila [after burial in the sand] present a curious arrangement. At each of the nodes of their long stolons creeping beneath the surface of the soil, a small branch, often forked at apex, is developed, which grows vertically upward and whose length depends upon the thickness of the stratum it must traverse; its growth only ceases when it reaches the surface, whether that be near or distant. The leaves developed upon these ascending branches are always directed toward the light, in spite of the burial of the plant." Massart. Mém. Soc. Roy. Bot. de Belgique, vol. 32, pt. 1, p. 31. 1893.

[4] Compare Volkens, Flora der ägyp.-arab. Wüste, pp. 24, 25, and Coville, Contr. U. S. Natl. Herb., vol. 4, p. 47.

secondary roots).—This mode of growth is exemplified in *Rubus villosus* (*canadensis*) and *R. trivialis*, in most of the woody lianas (when unable to find supporting objects), and in two herbaceous species of Leguminosae, *Phaseolus helvolus* and *Bradburya* (*Centrosema*) *virginiana.*[1]

3. The radiant form, which may be regarded as a phase of the preceding, is exhibited by certain—chiefly annual—species (fig. 72), possessing a well-defined vertical taproot, which is either slender (as in *Mollugo verticillata*, *Euphorbia polygonifolia*, *Diodia teres*) or rather stout (as in *Lechea maritima*, *Oenothera humifusa*, *Meibomia arenicola*, *Cakile edentula*). In this form the stem branches at the surface of the ground, and the branches, lying flat upon the sand (only the

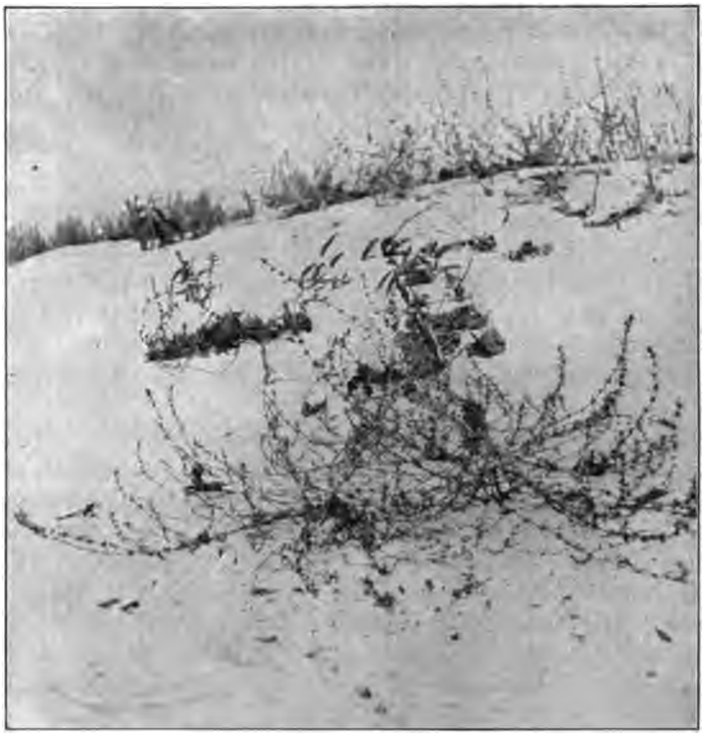

FIG. 72.—*Diodia teres* on the middle dunes near Oceanview, Va., illustrating the radiant form.

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[1] The Pes-caprae vegetation form, which has creeping stems sending numerous secondary roots into the soil, may, perhaps, be regarded as a further development of this habit. It is a form very characteristic of the tropical strand, but hardly not represented on the Virginia coast. Farther south, near Cape Hatteras, humble representatives of it occur on the edges of the salt marsh. On the coast of Georgia the species which gives a name to this form, *Ipomoea pes-caprae*, reaches its northern limit in America.

lower in Cakile), radiate in all directions like the spokes of a wheel. *Oenothera humifusa* is a particularly characteristic representative of the radiant form, one specimen observed having 21 branches from 3 to 9 decimeters (1 to 3 feet) in length. In Lechea it is the sterile, leafy, basal shoots that assume this form. The root in this species is comparatively long (about 3 decimeters) and vertical. In Meibomia the longest branches sometimes measure 9 decimeters (3 feet) in length. It is possible that the radiant form, as well as the preceding, is also useful to the plant by retarding evaporation from the area of sand thus shaded, consequently insuring a supply of water near the surface of the soil between rains. As the under side of the stems and leaves of plants which have this habit of growth are effectually protected against light and heat radiated from the surface of the sand, and to a large extent from exposure to the air, their rate of transpiration must be proportionately much less than in plants not possessing this habit.

4. *The rosette form.*—"Rosette plants," which have most of their leaves at the base of the stem and appressed to the soil, are protected in the same manner as plants of the radiant form. They are rare on the strand of Virginia and North Carolina, but are not uncommon on the coast of northern Europe. Two (probably) winter annuals, *Gnaphalium purpureum* and *Linaria canadensis*, have their basal leaves arranged in a flat rosette. In the latter species these are borne on short horizontal branches.

5. *The cushion or hassock ("Polster") form.*—This life form, which is so strikingly developed in the high Andes, in Australasia, and elsewhere, is hardly to be included among those of the Virginia strand, unless one refers here the peculiar mode of growth of *Hudsonia tomentosa*, which has numerous short, erect branches. These are densely clothed with appressed, scale-like leaves, and stand closely together. The roots of the Hudsonia are small (the longest about 15 centimeters, 6 inches, long), and afford the plant but a weak anchorage in the soil. Consequently the species grows most abundantly in the sheltered hollows among the dunes.

6. *The sod form ("Rasenform").*—This is represented by *Festuca rubra* alone, and does not occur in the dune area proper.

7. *The thicket form.*—This life form, closely analogous to the two preceding, characterizes several of the shrubby species, notably *Myrica carolinensis*. Farther south along the coast *Ilex vomitoria*, *Quercus virginiana*, and other species form strand thickets.[1] By this mode of growth the individual plants are in large measure protected against the sun and the wind, and the habit may well be interpreted as an adaptation against excessive transpiration, as well as against the mechanical force of the wind. The compact, rounded

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[1] Kearney, Contr. U. S. Nat. Herb., vol. 5, p. 272.

form, with numerous short, rigid branches, already described as being sometimes assumed by the live oak, may have similar advantages.

8. *Plants with subterranean storage.*—Bulbs, tubers, and other strong, local thickenings of underground parts, which are greatly developed in most arid regions, are not frequent among the dunes. *Cyperus grayi* and *C. cylindricus* have corm-like thickenings at the bases of the stems. Woody, tuber-like swellings occur on the rootstocks of the species of Smilax, and were also observed on the roots in young plants of the live oak. The possession of a subterranean food reservoir is unquestionably an advantage to a plant which is liable to burial by the sand.

9. *Annuals.*—In very arid regions annual plants often avoid the long period of drought by completing their course of life in a few weeks of the growing season, and are therefore designated as "ephemeral."[1] On the strand annuals are numerous in species and individuals, but there is no dry season, properly so called, to be guarded against, so the different species reach the acme of their development at different seasons. The annual life habit is probably more serviceable to dune plants as a protection against being uprooted or buried. This is an ever-present danger in the sand-strand formation, and one to which species with a long life period are of course most liable. Besides the radiantly growing species already enumerated, the following annuals are frequent: *Festuca octoflora*, *Aira praecox* (in woods behind the dunes), *Cenchrus tribuloides macrocephalus*, *Sarothra gentianoides*, and depauperate *Erigeron canadensis*, the last two preferring moist sand in the hollows.

PROTECTION AGAINST EXCESSIVE TRANSPIRATION.

A number of causes render it necessary that strand vegetation should be guarded against too great loss of water by transpiration from the leaves, just as plants of truly arid regions must be similarly protected. The environmental factors which induce such peculiarities of structure are, however, somewhat different in the two cases. Here, as in most maritime regions, atmospheric humidity is abundant and pretty equally distributed throughout the year. Furthermore, there is no lack of water in the dune sands at a usual depth of only 15 to 30 centimeters (6 to 12 inches) below the surface, so that all except the smaller (chiefly annual) herbaceous plants could readily obtain an abundant supply at all times, were it not for another factor, the presence in the soil of certain salts, particularly sodium chloride.

The life conditions of the strand which are probably the most effective causes of protective modifications of this nature may be stated as follows:

1. Strong insolation, and much light reflected from the surface of the white sand.
2. Heat, often intense, during most of the growing season. The

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[1] Compare Volkens's Fl. der Ägypt.-arab. Wüste, pp. 20, 40.

superficial layer of sand becomes greatly heated and very dry when exposed to the sun, although the soil beneath remains always cool and moist.

3. Exposure to almost constant and often strong currents of air, which keep the atmospheric envelope of the plant always changing, hence never saturated, and thus stimulate transpiration.

4. Presence in the soil of sodium chloride, in relatively large quantity. As has already been remarked, it is only in that portion of the sand strand which is very near the waves that sodium chloride exists in quantity sufficient greatly to affect vegetation.

Modifications of structure that probably serve the plant by protecting it against the excessive transpiration that the factors just enumerated tend to induce are rather numerous in the sand-strand vegetation. Some characters are almost certainly adaptations to this end, while the value of others is more doubtful. As a rule it is the leaf structure rather than the whole form and habit of the plant that is most obviously concerned. Among the most noteworthy peculiarities and modifications are:

(1) Those which effect a reduction of the transpiring surface. The most important of these are:

(*a*) Leaves small or narrow, as in *Helianthemum canadense*, *Lechea maritima*, *Salsola kali*, *Mollugo verticillata*, *Oenothera humifusa*, *Diodia teres*, *Linaria canadensis*, and especially *Hudsonia tomentosa* and *Sarothra gentianoides*. The last two species have scale-like leaves.

(*b*) Leaves with the power of becoming conduplicate or involute. This character is conspicuous in many of the grasses, notably *Panicum amarum*, *Spartina patens*, *Uniola paniculata*, and *Ammophila arenaria*, in which most of the stomata lie on the leaf surface thus protected, while the cuticle and epidermis walls are much more strongly thickened on the exposed (dorsal) surface, which is hard and polished. In Panicum and Ammophila the leaves are strongly involute on dry, sunny days, but become nearly plane in wet weather. The leaf margins of *Quercus virginiana* and of *Rubus cuneifolius* are somewhat revolute when the leaf is exposed to strong sunlight. This serves in some degree to protect the dorsal (under) surface, in which lie the stomata.

(2) Position of the leaves. These are nearly vertical in many of the grass-like plants. In *Smilax glauca*, also, when exposed to strong insolation, the leaves assume a nearly vertical position, thus opposing the glaucous under surface to the light and giving the plant a very characteristic appearance. The same phenomenon occurs, but in a less degree, in *Rubus cuneifolius*, which similarly opposes its tomentous lower leaf surface to a strong light.

(3) The surface protected by various outgrowths or modifications of the epidermis.

(*a*) Thickening of the cuticle of the epidermis cells, which is particularly noticeable in the large grasses and some of the woody plants with mostly evergreen leaves, as *Smilax* spp., *Quercus virginiana*, *Gelsemium sempervirens*, etc., but is common to nearly all the strand species. A surface which exhibits great thickening of the cuticle is usually not otherwise protected. Where a dense covering of hairs or other means of protection exists the cuticle is apt to be comparatively thin, e. g., in *Oenothera humifusa.* The polished surface which usually accompanies such thickening may possibly be useful to the plant by reflecting some of the light rays which fall upon the leaves. A rough surface of the cuticle, due either to wrinkles or to warts, characterizes some species of this formation, e. g., *Lonicera sempervirens* and *Galium hispidulum.* In the latter plant the thick cuticle is both strongly wrinkled and papillose. It has been suggested that such roughening is useful by diverting some of the incident light rays.

(*b*) A thin coating of wax, giving the surface a glaucous appearance. *Panicum amarum* is glaucous all over, while *Smilax glauca* and *Lonicera sempervirens* have the lower leaf surface conspicuously wax-coated.

(*c*) A dense covering of hairs. These may be simple, in which case they are often elongated, and form a villous or tomentous covering: on both surfaces of the leaf in *Oenothera humifusa* (stomata about equally numerous on both surfaces), *Hudsonia tomentosa*, and *Lechea maritima;* only on the under leaf surface in *Rubus cuneifolius.* Other species have hairs that are irregularly branched, as *Physalis viscosa*, or stellate and scale-like, as on the leaves of *Helianthemum canadense* and the lower leaf surface of the live oak (*Quercus virginiana*). Short, stout, thick-walled, unicellular hairs also line the walls of the furrows on the ventral (upper) leaf surface (where most of the stomata are placed) in such grasses as *Uniola paniculata*, *Ammophila arenaria*, and *Spartina patens*, thus preventing a rapid movement of the air about the stomata. Similar hairs also occur on the dorsal leaf surface of *Lonicera sempervirens* and on both surfaces in *Galium hispidulum*, but probably not in sufficient numbers to be of service in reducing transpiration. As noted above, the cuticle is usually thin where the surface is protected by a dense coat of hairs.[1]

(4) Modifications of the internal structure of the leaves. In the few species of the Sand Strand formation whose leaves are orthotropic (vertical) or approximately so, there is a tendency to isolateral structure of those organs. In other words, the two faces of the leaf, ventral and dorsal, are alike or nearly alike. Thus the leaves of *Smilax*

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[1] The bicellular hairs of Lechea and Hudsonia, of a type apparently peculiar to the family Cistaceae, are described and figured (for *Lechea maritima*) in the chapter on Anatomy. Such hairs, together with glandular and stellate ones, also occur in *Helianthemum canadense*, the third representative of this family in the sand strand of the Dismal Swamp region.

glauca are partially, and those of *Lechea maritima* are almost perfectly, isolateral. In *Galium hispidulum* the epidermis is nearly alike on both faces (stomata present, but in relatively small number, on the ventral face also), while the mesophyll is differentiated. But this is much more commonly the case in the Salt Marsh formation, the leaves of most plants of the Sand Strand being plagiotropic (more or less nearly horizontal) in position and bifacial or dorsiventral in structure. In two important points leaves of the latter type exhibit adaptations that help to protect against excessive transpiration, first, in the arrangement of the chlorophyll tissue, and second in that of the stomata.

(*a*) Chlorenchyma. In by far the greater number of plants of this formation whose leaves are strongly bifacial (and such is the case with almost all the dicotyledons) there is a sharp differentiation of the chlorophyll tissue into palisade and pneumatic tissue. The first consists normally of cells which are high (their diameter much greater at right angles to than parallel to the surface) and form a very compact tissue, usually without intercellular spaces. In most of the plants with which we are here concerned the palisade tissue forms a single layer, but in some there are two or even three layers. It is widely believed that this arrangement of the layer or layers of chlorophyll tissue which lie nearest that surface of the leaf (the ventral) which is exposed to the strongest light serves, among other purposes,[1] as a means of diminishing transpiration. This compact tissue prevents the access to the more open tissue beneath of a large proportion of the light and heat rays which strike the plant.

The more open pneumatic tissue or spongy parenchyma which is thus protected consists, usually, of nearly isodiametric cells. These are often irregular in form and have their neighboring walls separated by numerous air spaces. It is obvious that if such tissue lay directly beneath the epidermis of the upper surface of the leaf, the loss of water from that organ would be much greater.

(*b*) Stomata. Corresponding to the arrangement of the palisade tissue upon the ventral or upper, and of the open pneumatic tissue upon the dorsal or lower side of the leaf, in most of the strand plants of this region the stomata are either all, or by far the greater number of them, situated in the lower (dorsal) surface. The pores, as well as the air chambers into which they open, are thus shielded by the entire thickness of the leaf from the direct access of the incident rays. This is conspicuously true of the woody plants of the Sand Strand, e. g., *Smilax bona-nox*, *Quercus virginiana*, *Myrica carolinensis*, *Gelsemium sempervirens*, *Lonicera sempervirens*, etc.

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[1] The controlling factor in the strong development of palisade tissue is, however, intense light and the consequent opportunity for a great increase of assimilatory activity. For a brief discussion of this question, which has been ably treated by Stahl, Hinriches, Wagner, and others, see Haberloudt Pflanzenanat., 2te Aufl. 252–255.

In most of the grasses, on the other hand, the stomata are most numerous on the ventral or upper face, e. g., *Ammophila arenaria*, *Panicum amarum*, *Uniola paniculata*, *Spartina patens*. But here they are doubly or triply protected by the involution of the leaf blades, by their position in furrows, and often by the presence of stout hairs lining the wall of the furrows. Furthermore, the approximately vertical position assumed by such involute leaves diminishes the angle at which they are encountered by the light rays.

(*c*) The mestome or fibro-vascular bundles of the stems and leaves in many strand plants are more or less completely enveloped by massive groups of very thick-walled stereome. This undoubtedly serves in great degree to protect the ascending and descending fluids from evaporation.

(5) Succulency. As was stated in the discussion of the Salt Marsh formation, succulency is largely due to a strong development in the interior of the organ, whether stem or leaf, of thin-walled, often colorless parenchyma, which is believed to perform the function of a water-storage tissue. This modification is especially characteristic of desert plants, notably Cactaceae, but is also not infrequent among strand plants, especially in the salt marshes.[1] Succulent species of the sand strand are either—

(*a*) Stem succulents, with leaves much reduced and a partial or complete assumption by the stem of the functions of transpiration and assimilation, e. g., *Opuntia opuntia*, or—

(*b*) Leaf succulents, with well-developed, functionally active, fleshy leaves, but often exhibiting, at the same time, some degree of succulency in the stem, e. g., *Cakile edentula*, *Iva imbricata*, *Euphorbia polygonifolia*, and, to a minor extent, *Yucca filamentosa* (bases of the leaves).

It is well known that fleshy plants, while holding a larger supply of water in their tissues than do nonsucculent species, also give up their water less readily, and are therefore excellently adapted against excessive transpiration.

(6) Excretion of aromatic, volatile oils. It has been suggested[2] that plants which excrete essential oils are thereby protected to some extent against loss of water. By evaporation of these oils an envelope of aromatic air is formed about the plant, which, according to Tyndall,

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[1] Massart (Mem. Soc. Roy. Bot. de Belgique, 32, pt. 1, p. 18) notes that succulents are much more frequent in the salt marshes than on the sand strand of Belgium. This he attributes to the effect of the strong, sand-laden winds that blow over the beach and dunes and riddle the soft, unprotected tissues of fleshy plants. He remarks that on the sea-cliffs of Normandy succulent plants, being less exposed to this danger, are more numerous.

[2] Haberlandt, Physiologische Pflanzenanatomie, p. 325, ed. 2, p. 436; Volkens, Flora der ägypt.-arab. Wüste, p. 46; Warming, Ökolog. Pflanzengeog., p. 195.

is less pervious to heat rays than is ordinary atmosphere. How effective this may be is yet very doubtful,[1] but it is not to be denied that such aromatic plants are much more abundant in dry soils and climates where the water supply of the plant needs to be jealously guarded than where other conditions prevail. On the dunes the principal species thus characterized are *Myrica carolinensis*, *Iva imbricata*, *Chenopodium anthelminticum*, and *Monarda punctata*.

(7). Formation of a sand envelope around the roots. About the root fibers of certain grasses (notably *Aristida* spp.) of the North African deserts, Volkens[2] observed the presence of a cylinder composed of sand grains that cohere with each other and adhere closely to the root hairs by means of a viscous excretion from the latter. In the deserts of Arizona and in other arid sandy wastes the same phenomenon occurs. This Volkens believes to be a protection against excessive loss of water in its passage through the axial vascular strand of the root. In *Ammophila arenaria* and *Uniola paniculata*, on the Virginia coast, it was observed that sand grains cling tightly to the persistent root hairs, often adhering even when the plant is uprooted and roughly handled, although no viscous excretion was detected. Some protection may thus be afforded the plants in question against loss of water in its course through long roots, although the adaptation is obviously much less perfect than in grasses of the deserts.

(8) Development of tunicated bases of the stems (especially in Gramineae). The persistence of the bases of old sheaths at the foot of the culms in Gramineae, as pointed out by Hackel, is a character especially noticeable in grasses of arid regions. It is believed to afford protection against transpiration from the base of the culm, which rests in the frequently much-heated surface sand. The enveloping sheaths, therefore, perform the same function as do the homologous dry outer scales of many bulbs, and are said to be further useful in some cases as a reservoir for water, which is held between the closely appressed sheaths. In *Uniola paniculata*, *Ammophila arenaria*, and *Panicum amarum*, among dune grasses, the tunic sheaths may serve the former purpose, but do not form a dense enough covering to be useful for storage of water, even were there necessity for such a structure in strand plants of this moist climate.

The strand plants of this region generally differ from xerophytic formations elsewhere in their lack of those specialized structures which enable the plant to reserve water against a period of drought.[3]

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[1] Pfeffer (Pflanzenphys. 2te Auflage 1:501) considers this absorption "as hardly of high importance" for protection against loss by water.

[2] Flora der ägypt.-arab. Wüste, p. 25.

[3] E. g., the water hairs of species of Mesembryanthemum in the Sahara (Volkens, Flora der ägypt.-arab. Wüste, p. 53) and the cup-like leaf bases of species of Tillandsia and other tropical epiphytes (Schimper, Die epiphytische Vegetation Amerikas, pp. 73, 74, etc., 1888).

Succulency of subaerial organs was the only kind of water-storage apparatus detected in this vegetation.

Owing to the possession of various protections against excessive loss of water, most strand plants are very slow to wilt when detached from the soil.

PROTECTION AGAINST EXCESSIVE LIGHT.

Several of the modifications described as protecting against too great transpiration are perhaps equally valuable to the plant by preventing the injurious action of too strong and long-continued light. In the present state of our knowledge, however, it is often not possible to distinguish between the operation of these two factors and the resulting modifications of the organism.

The development of thorn-like branches (as in *Prunus angustifolia*); of prickles (*Smilax* spp., *Rubus* spp., *Aralia spinosa*, *Zanthoxylum clava-herculis*); of spines (*Opuntia opuntia* and the leaf tips of *Yucca filamentosa*) is in all probability a consequence of the physical conditions (great heat and strong light) which render necessary protection against excessive loss of water. It is hardly conceivable, however, that these structures are themselves of any use to the plant as a protection against such conditions. Prickly and thorny plants are most abundant on the inner slope of the fixed dunes and in the woods behind them, where the heat is more intense and the soil is drier than anywhere else in the Dismal Swamp region.

POLLINATION.

No important observations were made in regard to the pollination of the flowers of strand plants. Anemophilous fecundation, however, undoubtedly predominates. The species which can safely be referred to one or the other method of pollination are as follows:

Anemophilous: All Gramineae, Cyperaceae, Juncaceae, Myrica, Quercus, Chenopodium, *Iva imbricata*, Xanthium.

Self-fertilizing: *Lechea maritima.*

Entomophilous: *Oenothera humifusa, Monarda punctata, Gelsemium sempervirens, Tecoma radicans, Lonicera sempervirens.*

DISSEMINATION OF SEEDS.

Structures, especially developed in or about the fruits, which are useful to the plant in the dissemination of its seeds occur in many of the strand plants, although they are doubtless in most cases a heritage from inland ancestors rather than modifications acquired after residence upon the strand. The majority of these are adaptations to transportation by the wind, although other methods are not lacking. The various structures may be classified as follows:

(1) Adaptations to wind transportation.

(*a*) Specific gravity small in proportion to size, as in the spikelets of Gramineae (*Spartina patens*, *Uniola paniculata*, *Ammophila* *arenaria*), and in the indehiscent siliques of Cakile and the fruits with corky ridges of *Diodia virginiana*.

(*b*) Development of special structures which serve as sails: Represented by the wings in *Salsola kali* and *Tecoma radicans*, and hairs (pappus) in *Baccharis halimifolia* and *Eupatorium capillifolium*.

(*c*) Tumble-weed structure: The entire panicle breaks off near the base of the culms in *Eragrostis pectinacea* and *E. refracta*, and rolls over the ground, its progress being facilitated by the horizontally spreading branches, which act as sails, thus behaving like the prolongation of the rhachides in Spinifex.[1] The breaking off of the panicle is expedited by the slenderness of the lowest internodes of the culm.

(2) Adaptations to transportations by animals.

(*a*) Edible character of fruit: Species with fleshy fruits are rather numerous on the dunes, although *Physalis viscosa* is the only strictly maritime species thus characterized. Others are *Diospyros virginiana*, *Prunus serotina*, *P. angustifolia*, *Rubus cuneifolius*, *R. villosus* (*canadensis*), *Lonicera sempervirens*, *Vitis rotundifolia*, and *V. aestivalis*.

(*b*) Apparatus for attachment to the hair of animals, as in the burs of *Xanthium* sp. and of *Cenchrus tribuloides macrocephalus*.

GENERAL ASPECTS OF THE STRAND VEGETATION.

The general facies of the strand vegetation is somber and monotonous. Bright hues, whether of the vegetative or the floral organs of plants, are comparatively infrequent and contribute but slightly to the general effect. This prevailing lack of vivid color is due partly to the sparseness of the plant covering, which leaves the exposed soil as one of the chief color elements in the landscape, and partly to the various protective arrangments already detailed, which more or less conceal the green coloring matter. *Iva imbricata* is almost the only bright-green plant of the open dunes. On the other hand, Myrica (resinous) has a brown-green color, Oenothera (villous) is almost white, Hudsonia (tomentous) is gray, Ammophila (thick cuticle) is silvery green, *Panicum amarum* (glaucous) is blue green, and Cakile (succulent) is yellowish. Myrica gives the prevailing color to the middle dune area. Gaily tinted flowers are those of *Lonicera sempervirens* and *Tecoma radicans* (red), *Linaria canadensis* (blue), and *Oenothera humifusa*, *Hudsonia tomentosa*, and Gelsemium; the last three, being yellow, are less conspicuous amid the sands. Owing to the paucity of individuals, however, even the brilliantly colored flowers add little brightness to the aspect of this formation.

Poverty of species, as well as of individuals, characterizes the strand vegetation of this as of other regions. Only about 50 species, belonging to 40 genera and 26 families, are properly strand plants in the Dismal Swamp country. Of the total number, no less than 12 are Gramineae. Mosses and saprophytic, fleshy fungi are either wanting or are present in such small numbers as to play an insignificant part in the associations. Some lichens occur upon trees and shrubs, but do not, as in parts of northern Europe, cover the ground on the fixed inner dunes. Parasites, epiphytes, and saprophytes are biological forms which are not represented by the higher plants of the true strand formation (either marsh or sand strand). Their absence could almost be predicated from a knowledge of the life conditions.

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[1] See Goebel, Pflanzenbiolog. Schilderungen, Theil 1, pp. 135 to 138 (1889); Schimper, Indo-malayische Strand-flora, p. 81.

A few introduced weeds, such as *Capriola* (*Cynodon*) *dactylon*, *Rumex acetosella*, and *Solanum nigrum*, invade the Sand-Strand formation, but in numbers so small as to be unimportant. Broadly speaking, the flora of the strand is an indigenous one, and a majority of its species are endemic to Atlantic North America.

NONHYGROPHILE INLAND FORMATIONS.

The nonhygrophile inland formations occupy that great body of land in the Dismal Swamp region which is neither wooded swamp, river marsh, salt marsh, nor sand strand. The major part of it lies north, east, and southeast of the Dismal Swamp proper. A small portion of the country west and northwest of the morass (near Suffolk) was visited in the course of this survey and is here included; but the Nansemond escarpment is to be understood as fixing the western limit of the Dismal Swamp region, and the higher land west of it is not treated in this report. Eastward and northeastward the wooded plain extends to the strand and salt-marsh areas bordering the Chesapeake and the Atlantic. South of the swamp, along Albemarle Sound, the same group of formations occurs, but was explored only near Edenton, N. C. Newbern, on the Neuse River, in North Carolina, which was twice visited, is considerably south of the Dismal Swamp region, but supplemental data obtained there are intercalated as being useful for comparison. The aquatic and palustrine vegetation of small marshes, ponds, and streams, intimately connected topographically with the wooded plain, are treated, for the sake of ecological continuity, under the heading of "Low Marsh formation."[1]

The whole area thus defined was probably in its natural condition covered with forest growth, but very much of it—more than one-half—has been divested of its original plant covering, and is now cultivated or in various stages of return to the forested condition. Cultivated fields, abandoned fields, roadsides, and waste ground have each their more or less distinctive plant covering, and will therefore be treated as separate plant formations.

The chief and almost the only factor regulating the ecological distribution of the inland vegetation is drainage. Quality of soil, depending upon whether sand, silt, or clay predominates, is chiefly important as affecting water conditions. Chemical differences play here a very subordinate part, and are practically limited to the possible action of humic acids in the more swampy soils.

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[1] P. 439, below.

FOREST FORMATIONS.

MIXED FOREST.

The forest which still covers large areas of the Coastal plain is usually a mixture of coniferous and of deciduous trees. Where the original conditions have not been disturbed, the loblolly pine (*Pinus taeda*) is still the dominant species, as it probably was originally in almost every part of the region where this formation prevails. Not infrequently, especially near the strand, *Pinus taeda* is still almost the only tree in tracts of considerable extent. Generally, however, hardwood species are largely intermixed, especially where the original growth of pine has been cut away. In the latter case it almost invariably follows that the various deciduous trees, which often form a low undergrowth in the pine woods, spring up into tall trees when the removal of the pines gives them the needed space for development. On stiffer soils, especially away from the sea, hardwoods of several species frequently constitute the strongly predominant or, even in small areas, sole element of the forest growth. Generally, however, the mixture of deciduous and of evergreen trees (pine) is so intimate that it is altogether inexpedient to attempt the delimitation of two distinct formations, one of evergreen, the other of deciduous forest, as is elsewhere often practicable. The better plan will be to present a discussion of this forest formation as a whole, and then descriptions of a series of small local areas, showing the actual association of species in each case with reference to the special conditions of soil. The data for such descriptions were in every case recorded on the spot, with notebook in hand.

Pinus taeda, the hard, short-leaf, loblolly, or old-field pine, as it is variously designated, is unquestionably the species which, as a proper tree,[1] is most abundant in this association. In its present condition this pine is most frequently a small tree, 8 or 10 meters high and 3 decimeters or less in diameter near the base (fig. 73). In this condition it is doubtless usually "second growth" on land from which the original forest has been cleared. On the innermost dunes and immediately behind them, as we have seen, the pine is also usually a small tree, but here it is for the most part the original growth that remains. Physical conditions are, in most cases, responsible for the small size of the trees in this situation, the soil being light and poor in plant food and the shelter from wind being slight. Farther inland, however, forested areas are frequently met with where the original growth of pine seems not to have been disturbed, and here the trees are often of rather imposing size, attaining a height of over 30 meters and a diameter, considerably above the base, of more than 6 decimeters. As a rule, however, trees of this size are seen only in limited tracts, on soils comparatively heavy and moist.

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[1] The sweet-gum (Liquidambar) is perhaps more abundant, if individuals below tree size (height of about 6 meters) are taken into account.

The renewal of the pine forest was somewhat carefully studied, and it was found that where the growth of pine has been removed deciduous trees usually take its place, except on the lightest, most sandy soils. On the other hand, abandoned fields, especially when first occupied by broom sedge (*Andropogon virginicus*), are gradually colonized by seedling pines. Inhabitants of the region who have observed the alternation of pine and of deciduous growth in their immediate neighborhood confirm this view. Exceptions occur, however. Sometimes in open pine woods young growth of the pine is abundant. Not rarely two adjacent fields, once cultivated but now left to nature, will show, the one a growth of seedling pines, the other

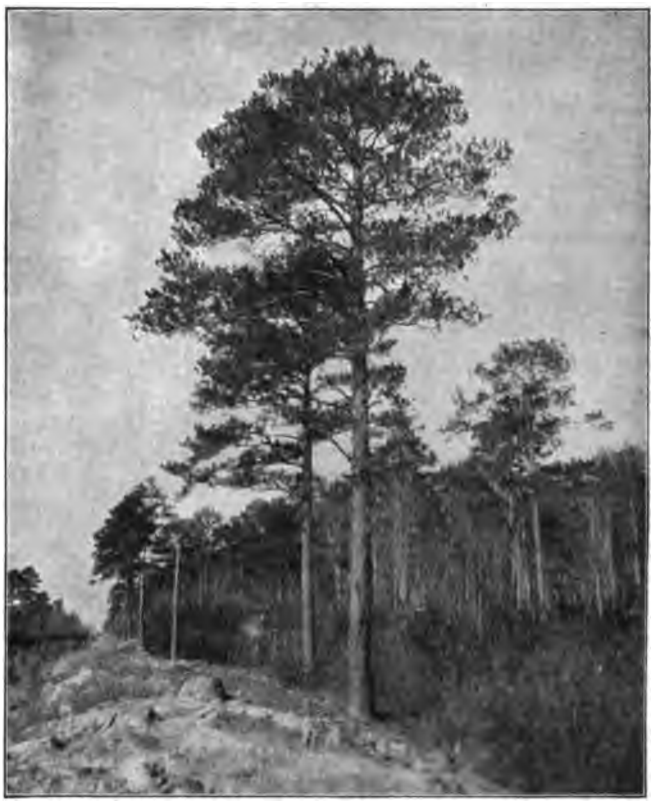

FIG. 73.—*Pinus taeda* along the Dismal Swamp Canal.

of young hardwoods. In such cases it was usually impossible to detect any corresponding difference in soil or drainage, and the result appeared to be due to what, for lack of a better word, we must term accident.[1]

The characteristic pine of the region is *P. taeda*. *P. echinata* (*mitis*) is not rare, but is comparatively an unimportant tree, seldom forming even groves. *P. palustris* (*australis*) was not observed, although it is known to occur sparingly in the region. It was formerly more common, but has been so eagerly sought on account of its valuable wood that to-day it is no longer noteworthy as an element of the forest formation.

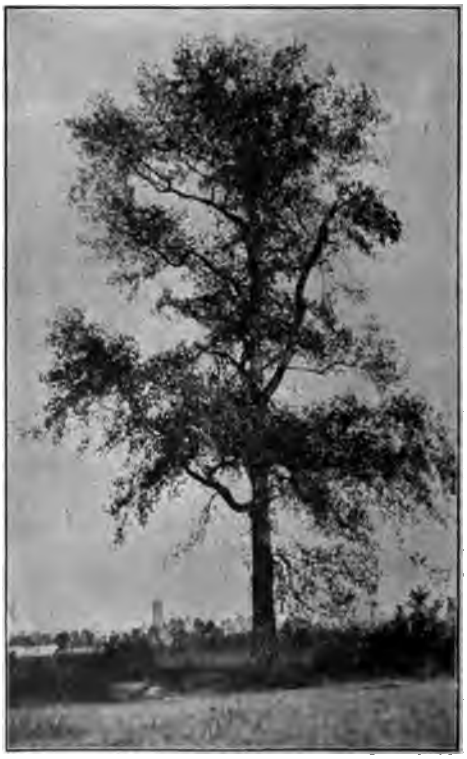

FIG. 74.—Sweet gum (*Liquidambar styraciflua*) near Norfolk, Va.

The most important deciduous-leaved species in this formation is the sweet gum (*Liquidambar styraciflua*), a handsome tree always conspicuous because of its star-shaped leaves and the corky thickening of its branches (figs. 74, 75). A number of oaks are abundant and conspicuous, notably the water oak (*Quercus nigra*), the white oak (*Q. alba*), the cow oak (*Q. michauxii*), the Spanish oak (*Q. digitata*), the post oak (*Q. minor*), and the willow oak (*Q. phellos*). Less common are the red oak (*Q. rubra*), the quercitron (*Q. velutina*), and the laurel oak (*Q. laurifolia*). The beech (*Fagus americana*) most abounds where the subsoil is particularly rich in clay or silt and therefore retentive of moisture. The red maple (*Acer rubrum*) is often abundant, but does not usually grow to considerable size outside the swamps. The mocker-nut hickory (*Hicoria alba*) and the tulip tree (*Liriodendron tulipifera*), although frequent, are less abundant than the preceding species. Dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), holly (*Ilex*

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[1] In some instances the seeding of pines in one field and not in a neighboring one may be accounted for by the position of the nearest pine forest and the prevailing direction of the winds. But many cases can not be so explained.

opaca), persimmon (*Diospyros virginiana*), and black gum (*Nyssa sylvatica*) are abundant, but do not usually occur as trees of even medium size. Other species of more or less importance in places are the black walnut (*Juglans nigra*), the pignut (*Hicoria glabra*), the red cedar (*Juniperus virginiana*), the red mulberry (*Morus rubra*), the hackberry (*Celtis occidentalis*), and the American elm (*Ulmus americana*). Chinquapin (*Castanea pumila*), sweet bay (*Persea pubescens*), sassafras (*Sassafras sassafras*), and black cherry (*Prunus serotina*) are commonly shrubs, and only here and there attain the size of small trees. The scurfy hickory (*Hicoria villosa*) and the redbud (*Cercis canadensis*) were observed only west of the Dismal Swamp, and there the yellow pine (*Pinus echinata*) and the post oak (*Quercus minor*) seem to be more abundant than they are east of the great morass.

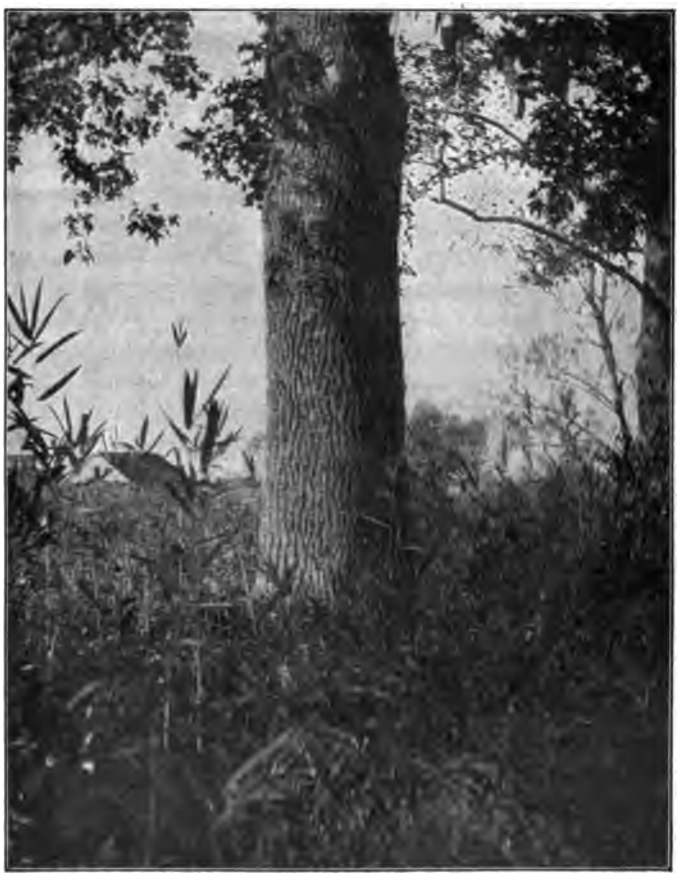

FIG. 75.—Sweet gum (*Liquidambar styraciflua*) at Wallaceton, Va.

All of these species, but especially the sweet gum and the oaks, also occur as undergrowth in the pine woods, mingling with species that are true shrubs. When an opening is afforded them, through the removal or thinning of the pine growth by fire or the ax, the hard woods grow up, often into stately forest trees. The sweet gum (Liquidambar) is not rarely 30 meters high and 1 to 1½ meters in diameter near the base. It grows to its largest size on the moister, heavier soils, but forms an abundant undergrowth in lighter, drier land. The beech not rarely forms small groves, excluding other trees, especially in low ground. Here it is frequently 25 meters high and 1 meter in diameter. The white oak, the red oak, the cow oak, and the willow oak are often lofty trees, with wide-spreading branches and trunks 1 meter through near the base. In other parts of eastern North America the different oaks are usually rather constant in their liking for dry or for wet soils, but like most of the forest trees they lose this selective power to a great extent in the Austroriparian area, especially very near the coast. Even here, however, it may be said, in a general way, that the cow oak, the water oak, the willow oak, and, in a minor degree, the white oak, prefer heavy soils with a large water content, while the Spanish oak, post oak, quercitron, and laurel oak are most at home on a drier, better-drained substratum of coarser texture.

Mingled with the young trees, which usually form the major part of the undergrowth, whether the forest is chiefly pine or chiefly hard wood, is a great variety of shrubs, large and small. Indeed, the abundance and density of the woody lower growth almost everywhere in the Dismal Swamp region is perhaps the most salient feature of its vegetation. Besides the species already mentioned as sometimes reaching the size of small trees, the following are worthy of note:

The wax myrtle, *Myrica carolinensis*, is abundant in pine woods which have a light soil, sometimes constituting almost the sole undergrowth, but usually mixed with sweet gum, dogwood, etc. *Vaccinium corymbosum*, *Rhus copallina*, *Aralia spinosa*, *Oxydendrum arboreum*, *Sassafras sassafras*, and *Diospyros virginiana* are likewise usually predominant in drier, sandy soils, while service berry (*Amelanchier botryapium*), "honeysuckle" (*Azalea canescens*), "shin-leaf" (*Symplocos tinctoria*), and "gallberry" (*Ilex glabra*) grow most abundantly upon a comparatively heavy moist substratum. *Callicarpa americana*, *Zanthoxylum clava-herculis*, and *Baccharis halimifolia* are important elements of the undergrowth only in the woods near the strand. The American laurel (*Kalmia latifolia*), storax (*Styrax grandifolia*), and sparkleberry (*Vaccinium arboreum*) are comparatively rare and local. The last-mentioned species was seen only west of Suffolk, where it reaches almost the size of a tree (5 meters high). A number of species which attain their best development in the wooded swamps are also frequent in the lower-lying parts of the nonpalustrine forest. Such are *Leucothoë racemosa*, *Aronia arbutifolia*, and *Clethra alnifolia*.

Mingled with these larger shrubs are numerous undershrubs and half shrubs. Such are *Vaccinium stamineum*, *V. vacillans*, *V. virgatum tenellum*, and *Gaylussacia frondosa* in the higher, drier woods. In moist low pine woods *Rubus hispidus* sometimes carpets the ground with its slender, trailing, prickly stems. *Arundinaria tecta*, usually 3 to 6 decimeters high, often forms a close covering in moist ground in open pine woods, excluding other growth almost entirely.

In this, as in other formations of the Coastal plain, woody climbers or lianas are almost everywhere abundant in the drier parts, forming dense tangles among the undergrowth. Where moisture is more abundant their large stems climb high on the trees. Hence most of the species having this life form show transitions in the inland forest from their typical habit on the dunes to that which they assume in the wooded swamps. One of the most abundant and generally distributed species is *Smilax rotundifolia*. *Rhus radicans*, *Vitis rotundifolia*, *V. aestivalis*, *Parthenocissus quinquefolia*, *Tecoma radicans*, and *Gelsemium sempervirens* are also very common. *Smilax glauca*, *S. bona-nox*, and *Lonicera sempervirens* are unimportant in number of individuals as compared with their abundance in the maritime vegetation, while *Bignonia crucigera* and *Berchemia scandens* are in this formation hardly to be regarded as more than waifs from the swamps. As illustrating the abundance and luxuriance of the liana form in this part of the Coastal Plain, it is worth mentioning that near Edenton, N. C., a large tulip tree (Liriodendron) afforded support to two specimens of Tecoma (one with a stem diameter of 8 centimeters), three specimens of Decumaria (one of them 4 centimeters through), one specimen of *Rhus radicans*, and one of Bignonia, all firmly attached to the trunk from near the ground, while a large *Smilax rotundifolia* joined forces from the top of a neighboring small tree.

The habit of the lianas is most various. In dry, comparatively open woods, where pine is almost the only timber, they usually trail upon the ground (*Vitis rotundifolia*, *V. aestivalis*, *Smilax bona-nox*, *Tecoma radicans*, *Gelsemium sempervirens*), or have long underground stems sending up occasional leafy and flowering branches (*Rhus radicans*). These are forms which the species usually assume on and near the dunes. Where the undergrowth is heavy they form dense tangles among the bushes (especially species of Vitis and Smilax.) While in lower moist ground where the growth of shrubs and small trees is rather scanty, and a transition to palustrine forest is therefore to be recognized, the lianas assume the high-climbing form (notably Gelsemium, *Vitis* spp., *Smilax rotundifolia*).

Owing to the density of the woody growth in most parts of this forest formation, herbaceous plants have a comparatively limited space for development. In the drier, more open pine woods, however, where woody undergrowth is sometimes sparse, the ground is often covered with grasses (*Danthonia sericea*, *D. spicata*, *Aristida* *purpurascens*, *Stipa arenacea*, *Andropogon* spp.), with Compositae (*Eupatorium* spp., *Elephantopus nudatus*, *Solidago odora*, *Ionactis* (*Aster*) *linariifolius*, *Sericocarpus linifolius*, *Helianthus atrorubens*, *Chrysopsis* spp., etc.), and with Leguminosae (species of Meibomia, Lespedeza, Galactia, Cracca (Tephrosia), Stylosanthes, *Bradburya* (*Centrosema*) *virginiana*, etc.). Other plants characteristic of such situations and the neighboring open spaces are: Vernal-flowering species, *Hieracium venosum*, *Iris verna*, *Linaria canadensis*, *Viola pedata*, and *Carduus spinosissimus*, the last being especially frequent at the edge of pine woods bordering salt marshes; flowering in summer, *Tragia urens*, *Jatropha stimulosa*, *Opuntia opuntia* (*vulgaris*), *Helianthemum canadense*, *Linum medium*, *L. floridanum*, *Polygala incarnata*, *Monarda punctata*, *Koellia mutica*, *K. hyssopifolia*, etc. Woods with a growth of this character are more frequent near the strand and along the larger streams.

In heavier moist soils, *Atamosco* (*Zephyranthes*) *atamasco*, with its beautiful large flowers opening in the spring, is locally gregarious, sometimes carpeting the ground with a sheet of white. *Nothoscordum bivalve* (*striatum*) and *Hypoxis hirsuta* (*erecta*) are in flower at the same season. It is rather remarkable that these three species, which are among the most noteworthy bulb-forming plants of the Dismal Swamp region, are all inhabitants of comparatively moist soil. Other vernal flowering species of rather damp soils in or near the edges of woods are *Mitchella repens*, *Asarum virginicum*, *Podophyllum peltatum*, *Smilacina racemosa*, etc. In autumn appear *Eupatorium coelestinum*, *E. semiserratum*, *E. serotinum*, *Gentiana elliottii*, *Lobelia puberula*, *Prenanthes alba*, *Erechtites hieracifolia*, *Panicum rostratum*, and *P. verrucosum*.

Pteris aquilina is here often very abundant in moist soils, although in regions where the surface is more broken it prefers dry slopes. Other ferns that are occasional in woods whose soil is still moister are species of Osmunda, Woodwardia, etc., but these belong properly to the wooded swamps. *Polystichum* (*Dryopteris*) *acrostichoides* is not infrequent.

Owing to the poverty in humus of the lighter, sandy soils, saprophytic fungi are there scarce. In the moister forests, however, they are often somewhat abundant, although seemingly less so than in many other forest regions of eastern North America. Of vascular saprophytes *Monotropa uniflora* was the only species noticed, although others probably occur. Parasitic leaf fungi are abundant, while vascular parasites are few. *Conopholis americana* is the most noteworthy holoparasitic phanerogam. Mosses and hepaticae, epiphytic and terrestrial, are by no means so abundant as in the wooded swamps. Except in "The Desert," near Cape Henry, where *Tillandsia usneoides* occurs on beeches, post oaks, and yellow pines, the only epiphytes are lichens (especially *Usnea* spp., on pines, etc.) and *Polypodium* *polypodioides* (*incanum*). The last is common, however, only in the recesses of the Dismal Swamp.

The aspect of the inland forest, where its primitive condition has been preserved, is usually that of a more or less compact assemblage of woody plants, forming, in typical examples, a series of three layers—the first of undershrubs, the second of tall shrubs and young trees, and the third of fully developed trees. Lianas may, as we have seen, enter copiously into any one or all of the layers, according to conditions which vary within short distances. More than three well-defined and approximately coordinate layers are rarely to be distinguished in the nonpalustrine forest formation; for, wherever herbaceous phanerogams, or mosses, or saprophytic fungi are present in considerable numbers, the layer of undershrubs, and often that of high shrubs, is correspondingly reduced.

As has already been pointed out, conditions of soil, especially of soil moisture, are often very different in the nonpalustrine forest, at points only a slight distance apart. A few steps serve to take us from a spot where the soil is dry, sandy, and almost devoid of humus to one where it is moist, contains a high percentage of silt, and is well stocked with humus. Every such difference of soil is accompanied by a corresponding change in the character of the vegetation. But, owing to the wide range of adaptability to difference in soil which is exhibited by most of the important woody plants of this formation, and the insensible gradations from the driest and lightest to the wettest and heaviest soils, it is not practicable to distinguish associations which have a general distribution in the region, and can be recognized as such at different points, although more extended study may render possible such segregation. Nevertheless, it is important that we should have a more exact conception of the physiognomy and constitution of the formation, and for this reason a number of limited tracts of the nonhygrophile forest, lying as far apart as possible in space and in character, will be described at some length. In each case the elements of the description were jotted down in a notebook on the spot, and it should therefore afford an accurate picture of actual conditions.

While there is much that the several examples have in common, as should be the case in the parts of a single formation, there are also more or less important distinguishing characters. Thus, in one spot *Pinus taeda* is almost the only tree, while in another deciduous species strongly predominate. Here young plants of Liquidambar form the principal undergrowth, there it is composed largely of Myrica or of different oaks. Lianas are abundant in one bit of woodland, while quite unimportant in another. Herbaceous plants may find plenty of space for development in a tract of open forest, while only a few meters distant they are crowded out by a dense growth of undershrubs. None of the following cases can be taken as a type of the virgin forests of the region. Everywhere conditions have been somewhat altered by man, especially in the removal of more or less of the original growth of pine:

1. Near the western branch of the Elizabeth River. Soil sandy, but with a stiff subsoil, consequently almost always moist. Forest of small pines (*P. taeda*), mostly 10 to 15 meters high, which are apparently giving place to hard woods, mostly sweet gum (Liquidambar) and oaks (*Quercus nigra*, *Q. phellos*, *Q. alba*). Black gum (*Nyssa sylvatica*) is also abundant among the pines, and is sometimes nearly as tall. Undergrowth dense, consisting largely of small red maple (*Acer rubrum*), *Oxydendrum arboreum*, *Rhus copallina*, *Gaylussacia frondosa*, *Clethra alnifolia*, Sassafras, *Aralia spinosa*, and much *Arundinaria tecta*.

2. Near the Southern Branch of the Elizabeth River. Soil gray, sandy, with about an inch of top mold, moist. Forest of small pines, chiefly 6 to 10 meters high, mixed with Liquidambar (the largest 22 meters high and 6 decimeters in diameter), *Quercus nigra*, *Q. digitata*, and *Oxydendrum arboreum*. Undergrowth rather dense, low, chiefly *Rhus copallina*, small Liquidambar, and *Ilex glabra*, with various other shrubs and young trees. In open spots species of Panicum, especially *P. laxiflorum*, are very abundant. Nearer the river the soil is drier and sandier, and *Myrica carolinensis* forms the major part of the undergrowth.

3. Near Kempsville, a typical inland locality east of Norfolk. Soil rather heavy (sand and silt), grayish in color, with about 5 centimeters of black top mold, very moist. Pines largely replaced by hardwoods—*Acer rubrum*, Liquidambar (the largest 30 meters high and 1 meter in diameter near the base), Liriodendron (occasionally very large), *Fagus americana*, *Quercus phellos*, *Q. michauxii*, *Q. alba*, *Q. velutina*, *Nyssa sylvatica*, *Carpinus caroliniana*. Undergrowth dense, consisting of small individuals of the deciduous trees, together with Oxydendrum, *Azalea canescens*, *Pyrus angustifolia*, *Aralia spinosa*, *Xolisma ligustrina*, etc. Lianas abundant and occasionally climbing high—*Smilax rotundifolia*, *Vitis rotundifolia*, *Rhus radicans*, *Parthenocissus quinquefolia*, and *Tecoma radicans*.

4. Lynnhaven Station. Soil a rather stiff, grayish loam with 2 or 3 centimeters of top mold. Trees almost exclusively *Pinus taeda*, 15 to 20 meters high and standing rather closely. Undergrowth largely of *Myrica carolinensis* (averaging 5 meters in height), with *Ilex glabra*, *Cornus florida*, Liquidambar, *Quercus phellos*, *Q. velutina*, *Q. nigra*, *Q. alba*, *Q. minor*, *Q. digitata*, *Acer rubrum*, *Ilex opaca* (one tree 12 meters high and 3 decimeters in diameter), *Persea pubescens*, *Nyssa sylvatica*, etc. Lianas not very abundant and chiefly low—*Smilax rotundifolia*, *Gelsemium sempervirens*.

5. Lynnhaven Station, about one-half kilometer from the preceding locality. Soil sandier, drier, with almost no humus. Pines low (8 meters or so) and more scattered. Undergrowth sparser and with less variety of species—Liquidambar, *Quercus digitata*, Myrica, Sassafras, *Rhus copallina*, *Prunus angustifolia*, *Rubus villosus*. Ground thinly covered with grasses, *Stipa arenacea*, etc., and other scattered herbs—*Chrysopsis graminifolia*, *Helianthus atrorubens*, etc.

6. Deep Creek, near the northeastern edge of the Dismal Swamp. Soil to a depth of 2 decimeters (8 inches) a moist, rich, brown loam, then stiffer, grayish, containing much silt. Small pines 12 to 18 meters (40 to 60 feet) high constitute hardly one-half of the forest, which includes *Quercus alba* (sometimes as tall as the pines), Liquidambar, *Nyssa sylvatica*, *Acer rubrum*, and, less important, Fagus, Liriodendron, *Ilex opaca*, *Quercus nigra*, *Quercus michauxii*, and Oxydendrum. Among the undergrowth, young hard wood trees with *Kalmia latifolia* and *Symplocos tinctoria* are most abundant, while *Ilex glabra*, *Aralia spinosa*, Arundinaria, Clethra, *Vaccinium corymbosum*, *Hamamelis virginiana*, *Leucothoë axillaris*, *Amelanchier botryapium*, etc., are common. Lianas are chiefly low, climbing over the bushes—Gelsemium, *Smilax rotundifolia*, *Vitis rotundifolia*,

and *Bignonia crucigera*. *Mitchella repens* and *Rubus hispidus* creep over the surface of the ground.

7. Near Edenton, south of the Dismal Swamp, near the edge of a tract of woodland. Soil sandy, and comparatively dry, with but slight content of humus. Trees, a few small scattered pines, with Liriodendron, *Quercus digitata*, and a low, open shrubby growth of Diospyros, *Rhus copallina*, Liquidambar, Oxydendrum, *Aralia spinosa*, Gelsemium, etc. Herbaceous growth abundant, of grasses (chiefly *Andropogon scoparius*); Compositae (*Eupatorium* spp., *Elephantopus nudatus*, *Chrysopsis graminifolia*, etc.); and, particularly conspicuous, various Leguminosae (*Cracca spicata*, Bradburya, *Stylosanthes biflora*, *Chamaecrista nictitans*, *Galactia volubilis*, species of Meibomia and of Lespedeza, *Crotalaria purshii*, etc.

8. Near Suffolk, west of the Dismal Swamp, top of a bluff about 9 meters (30 feet) high, on Cohoons Creek. Top soil to a depth of 15 centimeters (6 inches), a sandy, grayish-brown loam. Subsoil, for 7½ decimeters (30 inches), a fluffy, yellowish, sandy loam. Woodland open, the trees mostly 9 to 15 meters (30 to 50 feet) high, but some of the pines and white oaks attaining a height of 18 to 20 meters (60 to 70 feet). About half of the trees are *Pinus taeda*, the rest *Quercus minor*, giving place some little distance back from the stream to *Q. alba*, with *Q. velutina*, *Q. laurifolia*, *Q. nigra*, *Juniperus virginiana*, *Cornus florida*, *Castanea pumila* (9 meters, 30 feet, high), *Sassafras* (about 6 meters, 20 feet, high), *Vaccinium arboreum* (about 4½ meters, 15 feet, high), *Symplocos tinctoria* (one specimen, 4½ meters, 15 feet, high), *Hicoria villosa*, *Fagus americana*. All these plants are treelike in habit. Woody undergrowth is scanty, and in places the ground is quite bare between the trees. Small patches of *Opuntia opuntia* (*vulgaris*) and scattered plants of *Jatropha stimulosa*, *Stylosanthes riparia*, *Ruellia ciliosa*, *Asarum virginicum*, *Aristolochia serpentaria*, etc., also occur. Altogether the association is much like that upon the wooded bluffs along Lynnhaven Bay.

PINE BARRENS.

This formation, so characteristic of the Austroriparian area of the Lower Austral life zone in North America, is not present in its typical form in the region east, west, or north of the Dismal Swamp, but is first encountered along Albemarle Sound, e. g., near Edenton, N. C. There occur open pine forests, with comparatively little woody undergrowth, but with a more or less close carpet of grasses and other herbaceous plants covering the ground.

Where the soil, always sandy and comparatively poor in organic matter, is dry, grasses such as species of Andropogon, Panicum, and Danthonia prevail, mingled with forms belonging to numerous other families, particularly Leguminosae and Compositae. Worthy of mention are *Stylosanthes biflora*, *Psoralea pedunculata*, *Meibomia stricta*, *Elephantopus nudatus*, *Eupatorium linearifolium*, *Aster gracilis*, *Polygala mariana*, *Koellia hyssopifolia*, *Gratiola pilosa*, *Linum medium*, etc.

In somewhat moister but otherwise very similar soil sedges (species of Rynchospora), *Eupatorium rotundifolium*, *Rhexia mariana*, *Ascyrum stans*, *Bartonia virginica*, *Spiraea tomentosa*, *Ilysanthes gratioloides*, *Monniera acuminata*, etc., are characteristic. In small depressions, along streams, diminutive marshes are frequent, and here grasses give place almost entirely to sedges—*Rynchospora inexpansa*, *R. corniculata*, *Cyperus pseudoregetus*, *Eleocharis tortilis*, *Carex verrucosa*, as well as *Juncus setaceus*, *Habenaria cristata*, *Trachelospermum difforme* (a thin-stemmed liana), etc. In such spots woody undergrowth and lianas play a more important part than in the dry pine woods.

As we go farther south the Pine Barren formation becomes more and more the predominant element in the plant covering, and the number of species composing it increases proportionately. Moreover, the long-leaf pine (*Pinus palustris*) becomes more important in the forest growth. Near Newbern, N. C., for example, the drier, more open soil is occupied by grasses, in places by the characteristic wire grass (*Aristida stricta*) and the odd and handsome *Campulosus aromaticus* (*Ctenium americanum*) as well as a variety of other plants—*Linum floridanum*, *Ludwigia virgata*, *Hypericum pilosum*, *H. virgatum*, species of Lespedeza and Meibomia, *Rhynchosia tomentosa*, *Indigofera caroliana*, *Zornia bracteata*, *Eupatorium pinnatifidum*, *E. rotundifolium*, *Lacinaria liatris graminifolia*, *Solidago petiolaris*, etc.

Still greater is the diversity of species in the lower, marshy places. Here a variety of sedges, especially *Rynchospora* spp., *Carex verrucosa*, *Dichromena colorata*, and *Fuirena squarrosa* constitute the groundwork, while the pattern is formed of *Hypericum galioides* (flowers bright yellow), *Polygala lutea* (orange), *Aster paludosus* (blue), *Trilisa paniculata*, and *Carphephorus tomentosus* (purple), *Solidago pulverulenta* and *S. pilosa* (golden yellow), *Rhexia ciliosa* and *R. glabella* (rose-purple), and many others. In still wetter spots the superb *Habenaria blephariglottis* with large white and *H. cristata* with orange-colored flowers are abundant, and *Sarracenia flava* is occasional. Here also *Lycopodium alopecuroides* and often species of Sphagnum (*S. imbricatum* var., *S. brevicaule*) are abundant.

The showy flowers of a great variety of herbaceous plants are the characteristic feature of the pine barrens. They are much less conspicuous in the mixed forests. One is especially impressed with the floral wealth of this formation in early autumn, when the gay colors of many Compositae are everywhere a feature of the landscape.

CLEARED-LAND FORMATIONS—NONCULTURAL.

ARBOREOUS ASSOCIATIONS.

Where the original forest growth is artificially removed individual trees or small groves are often left standing, and, finding more room for lateral growth than in the crowded forest, they assume forms that are not commonly met with there. Such survivals of the forest are especially frequent on roadsides and about dwellings in the country. In the case of indigenous species it is, of course, often difficult to distinguish between trees which originally belonged to the forest and those which have been planted by man. Therefore, all native trees which occupy such habitats can best be included in this formation, unless it is clear that they owe their occurrence directly to human agency.

The commonest and at the same time the most handsome shade tree of the region is the willow oak (*Quercus phellos*), which is often planted about farmhouses and along the streets of towns, but also undoubtedly occurs as a remnant of the aboriginal plant covering, especially in low ground. This oak is frequently of great size, and, where its environment permits, of beautifully symmetrical form, with wide-spreading branches and rounded crown. Other species of oak, notably the water oak (*Q. nigra*), the red oak (*Q. rubra*), the white oak (*Q. alba*), and the quercitron (*Q. velutina*), are frequent on plantations. The beech (*Fagus americana*), the sweet gum (*Liquidambar styraciflua*), the tulip tree (*Liriodendron tulipifera*), and, more rarely, the mockernut hickory (*Hicoria alba*) grow to be magnificent trees when left standing in the open. The sassafras (*Sassafras sassafras*), the persimmon (*Diospyros virginiana*), and the chinquapin (*Castanea pumila*) occasionally attain arborescent size at roadsides. Here, as in other parts of North America, the red cedar (*Juniperus virginiana*) seems to be most at home along country roads, and is consequently a conspicuous feature of the landscape.

SHRUBBY ASSOCIATIONS—THICKETS AND HEDGES.

Fence rows, especially upon land that is not thoroughly cultivated, are commonly occupied by a low, woody growth, consisting of such normally arboreal species as the sweet gum (Liquidambar), the black cherry (*Prunus serotina*), and various oaks; of shrubs, e. g., persimmon (Diospyros), sassafras, sumac (*Rhus copallina*), chicasa plum (*Prunus angustifolia*), common blackberry (*Rubus* sp.), etc.; and of lianas, especially species of greenbrier (Smilax), the muscadine grape (*Vitis rotundifolia*), the yellow jessamine (*Gelsemium sempervirens*), the trumpet creeper (*Tecoma radicans*), and the poison vine (*Rhus radicans*). Where the soil is comparatively rich and moist the elder (*Sambucus canadensis*) often predominates, and is an exceedingly common plant along roadside ditches. The same association usually occupies the embankments of railways, except in the immediate vicinity of towns. Some of these plants, notably Sassafras, Diospyros, and Rhus, are abundant in old fields, and even among standing crops if these are not well cultivated.

Prunus angustifolia is common in dry, sterile soil at roadsides or in clearings and occasionally forms small dense thickets, growing to an average height of 1 to 1½ meters (4 or 5 feet), but is sometimes 3½ meters (12 feet) high, with a trunk 15 centimeters (6 inches) in diameter. The short thorny branches and the rather small and thickish leaves give the plant a distinctly xerophytic stamp. Where the Prunus grows closely other vegetation is almost entirely excluded. The sand blackberry (*Rubus cuneifolius*) is one of the most characteristic plants of similar situations and is likewise obviously xerophytic in its organization. Other woody species of sandy roadsides are *Crataegus uniflora*, and, with stems prostrate, *Rubus trivialis* and Gelsemium. With these are usually associated herbaceous plants—*Bradburya virginiana* with its showy purple flowers, *Stylosanthes biflora* and *S. riparia*, *Galactia volubilis*, various Compositae, *Monarda punctata*, *Gymnopogon ambiguus*, *Festuca octoflora*, etc.

Along roadside ditches, especially near the sea, *Baccharis halimifolia* (sometimes 2½ meters, 8 feet, high) and *Rosa carolina* are commonly associated.

HERBACEOUS ASSOCIATIONS.

Often entering into the above-described associations of shrubby plants, but more frequently forming more or less nearly pure herbaceous assemblages in old fields and roadsides where woody plants play a subordinate rôle, are various species, notably of Compositae and grasses. One of the most abundant of these is the broom sedge (*Andropogon virginicus*), which frequently forms a close covering in abandoned fields. With it are generally mingled small scattered shrubs and, notably, seedling pines (see above, p. 397).

Senecio tomentosus is, in spring, one of the most common and showy plants of the region. It is particularly abundant in low, rather moist ground, in fields and on waysides. Its tufts of white tomentous leaves are hardly less conspicuous in contrast with the surrounding vegetation than are its golden-yellow heads. In moist sandy soil, especially near the sea, a characteristic species is *Carduus spinosissimus*, a vernal flowering thistle with low, stout stems and large heads of pale yellow flowers. Exceedingly abundant at the same time of the year, but preferring the driest sand, is a small winter annual, *Linaria canadensis*. The bright blue flowers of this plant are conspicuous, notwithstanding their small size. Another vernal flowering species, bluets (*Houstonia coerulea*), is commonly associated with the Linaria. Two annual grasses, *Festuca myurus* and *F. octoflora*, and the small yellow clover, *Trifolium dubium*, are abundant in places. In late spring and early summer the sulphur-yellow heads of a cichoriaceous plant, *Sitilias* (*Pyrrhopappus*) *caroliniana*, are locally conspicuous at waysides. The Japan clover (*Lespedeza striata*) is another very abundant plant in such places; and likewise, in early summer, *Daucus carota* and *Achillea millefolium*.

In late summer and autumn large Compositae are the predominant herbs in fields and roadsides. The most characteristic and perhaps the most abundant herbaceous plant of the region is the hog weed or dog fennel (*Eupatorium capillifolium*) (fig. 76). Even in May the bright green, finely divided, Anthemis-like root leaves of this plant are conspicuous. By midsummer the stems are 3 to 6 decimeters (1 or 2 feet) high, wandlike and very leafy. In early autumn the large plume-like, greenish or purplish panicles of numerous small heads are seen everywhere, waving gracefully in the wind and making every fence corner a place of beauty. The plant when full grown has stout stems 6 to 12 decimeters (2 to 4 feet) high. It is nowhere more abundant and showy than along the banks of the Dismal Swamp canal, where it is associated with vast quantities of *Panicum proliferum* and *P. crus-galli.* Other species of Eupatorium with white flowers are abundant, notably *E. linearifolium* and *E. rotundifolium,* the latter preferring rather moist soil. Asters, especially *A. ericoides,* with numerous small, white-rayed heads, are prominent in the landscape. Golden-rods are likewise conspicuous, *S. canadensis* being the common roadside species. *Erigeron canadensis* and *Ambrosia artemisiaefolia* are exceedingly abundant. A very common plant along ditches in fields, less frequently covering the ground in low woods, is a tall, wandlike grass, *Erianthus contortus* (fig. 77), which in autumn is hardly inferior to *Eupatorium capillifolium* as a character plant of this formation.

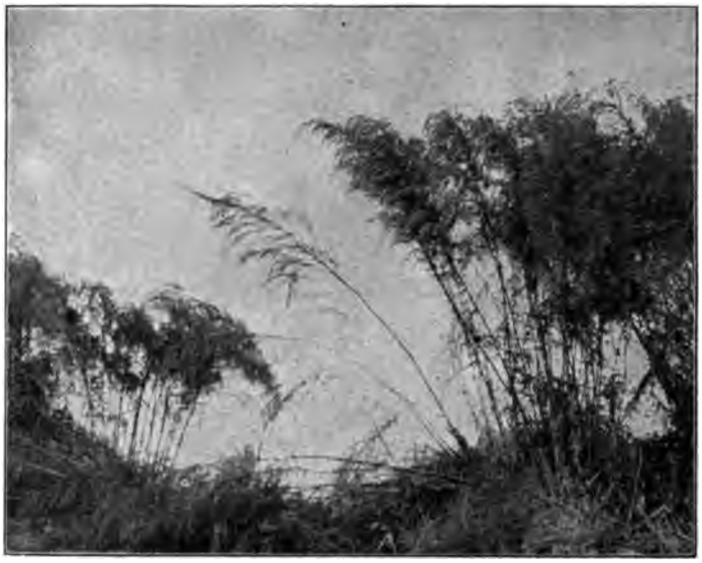

FIG. 76.—*Eupatorium capillifolium* on roadside near Wallaceton, Va.

Near towns and along the more-traveled highways, ruderal plants, introduced weeds, usually conquer the indigenous growth, but this is not always the case. For example, on the outskirts of even the larger seaport cities waste land is frequently occupied by an association of *Baccharis halimifolia, Eupatorium capillifolium,* and *Andropogon virginicus.*

CULTURAL FORMATIONS.

FIELD CROPS.

An extended account of the agricultural products of the region would not be in place here, but will be presented in another section of this report. Yet some discussion of the cultural formations is necessary to a complete description of the plant covering. The valuable bodies of cultivated land that have been reclaimed from the wooded swamps are included in this subdivision of the subject, because it is, of course, impossible to regard them as any longer forming a part of the hygrophile vegetation.

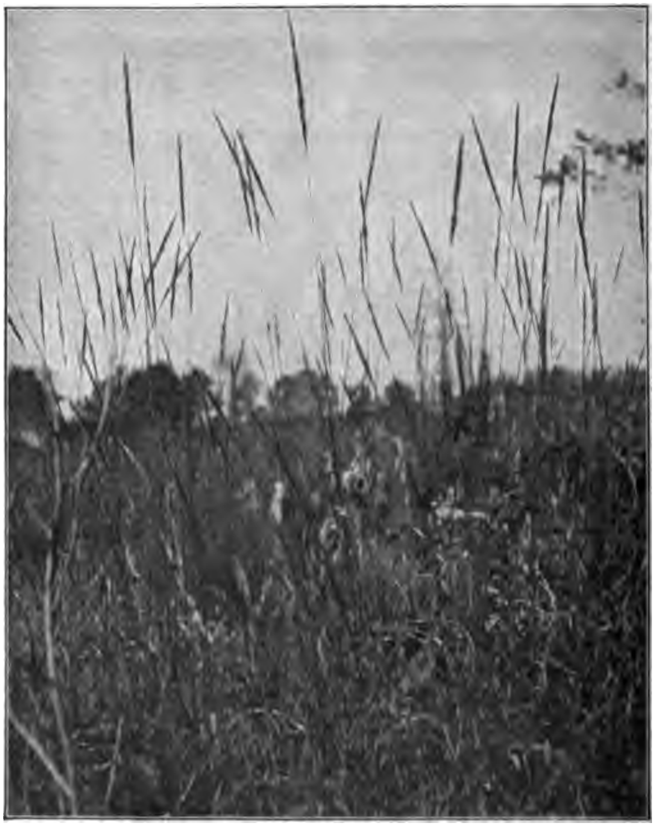

FIG. 77.—*Erianthus contortus* along a ditch near Portsmouth, Va.

Garden vegetables.—The principal field crops of the region east of the western border of the Dismal Swamp are, first and foremost, certain table vegetables and fruits, which are cultivated on a large scale, this being well known as one of the principal market-garden or "trucking" areas along the Atlantic coast. Of these plants, Irish potatoes hold the first place in quantity grown, with cabbages second, and strawberries third. Next in importance stand peas, beans (string and lima), tomatoes, and spinach. Sweet potatoes are much cultivated, and so are kale, asparagus, lettuce, cantaloupes, radishes, squash, and watermelons. Celery is raised in small quantity on the heavier swamp lands.

These "truck" crops are chiefly grown in the light, sandy soils, near salt water, although some of them, especially potatoes and, to a less extent, strawberries, are successfully cultivated on the stiffer, moister soils farther inland. Different vegetables occupy the land and mature at different seasons—e. g., kale and spinach in winter; radishes and asparagus in early spring; peas, cabbage, and potatoes in early summer; tomatoes and cantaloupes in midsummer; and sweet potatoes in early fall. Frequently two vegetables are cultivated together in the same field, or even in the same rows—e. g., cabbage and strawberries. Often second crops of some of the early vegetables are matured in autumn, notably peas and potatoès. After the removal of the earlier truck crops, indian corn is frequently planted on the land, although this cereal does not succeed as well on the light coastwise soils as on the heavier swamp soils inland. In the southern part of the region cotton is sometimes planted after the maturing of early truck crops. Frequently the land is allowed to lie idle during a great part of the summer, when it becomes occupied by a heavy spontaneous growth of grasses, notably crab grass (*Panicum sanguinale*), the principal uncultivated forage plant of the country.

The aspect of land thus occupied by extensive fields of garden vegetables is striking to the unaccustomed eye. Especially noteworthy in this respect are fields of strawberries, asparagus, and kale.

Cereals.—The principal cereal of the region is indian corn, which is much cultivated as a second crop upon land which was occupied earlier in the season by garden vegetables; but it is grown to best advantage upon the soils, rich in organic matter, which have been reclaimed from the Dismal Swamp. Here corn often grows to a height of 3½ meters (12 feet) without the use of fertilizers, and yields 15 to 30 hectoliters (40 to 80 bushels) of grain per acre. The effectiveness of this crop as an element of the landscape needs no comment.

Oats are frequently grown, especially in upland soils, at some distance from the coast, but never in great quantity. Small fields of rye and barley are occasionally seen. Rice, the upland variety, is cultivated to a considerable extent in the Albemarle Sound region of North Carolina. Wheat has been successfully grown, especially upon the swamp soils, but is no longer an important factor in the agricultural resources of the region.

Cotton.—Cotton is not cultivated to an important extent in Virginia, but is a staple crop in eastern North Carolina. Around Edenton it is grown largely upon warm, loamy upland soils. Near Newbern it is frequently sown upon land which had produced crops of vegetables earlier in the season. It would be quite superfluous to describe the appearance of fields of this beautiful plant, or to expatiate upon its prominence as a feature of the plant covering.

Forage plants.—Timothy (*Phleum pratense*) is cultivated with considerable success, but not to any great extent, on land cleared from the Dismal Swamp. Crimson clover (*Trifolium incarnatum*) grows well upon higher, lighter soil. The forage crop *par excellence* of the region is the cowpea (*Vigna catjang*), which is planted either alone or with indian corn, and usually after some truck crop has been gathered. Fields of German millet (*Chaetochloa italica*) are frequent. Orchard grass (*Dactylis glomerata*) is occasionally planted, and red clover (*Trifolium pratense*) makes excellent growth, especially on the heavier inland soils. Such grasses as perennial rye grass (*Lolium perenne*), orchard grass (Dactylis), blue grass (*Poa pratensis*), meadow fescue (*Festuca elatior*), velvet grass (*Holcus lanatus*), and legumes, e. g., vetches (*Vicia sativa*, *V. angustifolia*), clovers (*Trifolium repens*, *T. pratense*), and the black medick (*Medicago lupulina*), grow luxuriantly at the edges of roadside ditches, especially along the shell roads, where lime is abundant in the soil.

Other field crops.—Peanuts are not a staple crop in the region north and east of the Dismal Swamp. West of the swamp, however, this is one of the most important agricultural products. About Edenton, N. C., the peanut is, next to cotton, the principal crop, being grown usually upon the same type of warm, light, loamy soil which is preferred for the cultivation of cotton.

Tobacco is occasionally sown in small patches by the negroes, and is said to grow well upon light soils suitable to truck. South of the Dismal Swamp region, near Newbern, N. C., it is a more important crop, wrapper leaf being the usual type there cultivated.

Sorghum is grown here and there near Norfolk, usually in small quantity on farms, for home consumption.

CULTIVATED TREES.

Fruit trees.—Few orchard fruits are well adapted to conditions in this region. Apples are frequent, and a variety of summer apple does very well on the heavier soils. Peaches, cherries, and pears are occasionally planted, but rarely in large numbers. The fig is a favorite for planting about dwellings, and grows thriftily.

Shade and ornamental trees.—In addition to the indigenous trees already described, which occur at roadsides and about dwellings in the country, having survived the destruction of the forest, there are a number of species, some native, others introduced, which have evidently been conveyed by artificial means to the stations which they now occupy.

At Fortress Monroe, in the city of Norfolk, and elsewhere, live oaks are sometimes planted, and attain a good size, which is never the case in their natural habitat in this region (the strand). The buttonwood (*Platanus occidentalis*) is occasionally planted about country farmhouses. The silver poplar (*Populus alba*), and the paper mulberry (*Broussonetia papyrifera*) are favorite introduced shade trees, and are both pretty well naturalized. The osage orange (*Toxylon pomiferum*) is sometimes set out for hedges, attaining a height of 40 feet and a diameter near the base of the stem of 10 inches. In gardens in the towns the crape myrtle (*Lagerstroemia indica*) is abundantly planted, and grows to be an exceedingly ornamental small tree. The fig (*Ficus carica*) usually accompanies it. Less common in this latitude is the Chinaberry (*Melia azedarach*). *Albizzia julibrissin*, likewise a small tree, was not seen north of Edenton, but is there commonly naturalized near the town.

WEEDS.

The associations of largely indigenous species already described, which take possession of abandoned fields and country roadsides are not to be confused with the weed formation proper, which consists largely of species which have immigrated from other regions, especially from the Old World. This formation occupies cultivated land, especially near the towns, waysides along the principal lines of travel, and vacant lots, wharves, etc., in the cities and villages, as well as barnyards and inclosures generally in the country. An enumeration of all the weeds of the region would be out of place here; only the more conspicuous species will be mentioned in the following discussion.

Of cultivated land.—Chickweed or wintergreen (*Alsine media*) is one of the most abundant of weeds in truck land about Norfolk, being especially troublesome in strawberry fields during the cooler part of the year. Squirrel tail (*Hordeum pusillum*) is a very common vernal weed in the fields of garden vegetables, as are *Coronopus didymus* and sheep sorrel (*Rumex acetosella*), the last being one of the most characteristic weeds of the strawberry fields. Species of dock (*Rumex crispus*, *R. obtusifolius*), wild radish (*Raphanus raphanistrum*) and the mouse-ear chickweed (*Cerastium viscosum*) are likewise noteworthy among weeds, especially in spring. The broom rape (*Orobanche minor*) is exceedingly common among red clover in the country about Norfolk and Portsmouth, and is also parasitic upon the roots of other plants, notably the vetch (*Vicia sativa*). It is conspicuous in clover fields and on roadsides toward the beginning of summer.

From midsummer to early autumn a different group of weeds appears. Compositae such as the cocklebur (especially *Xanthium strumarium*), ragweed (*Ambrosia artemisiaefolia*), horseweed (*Leptilon canadense*), and dog fennel (*Eupatorium capillifolium*) are prominent. In the black corn lands along the eastern border of the Dismal

Swamp, cocklebur (*Xanthium strumarium*), morning-glory (*Ipomoea purpurea*), and *Sida spinosa* are the most abundant weeds. Near Newbern the small crow-foot grass (*Dactyloctenium aegyptiacum*) and *Eclipta alba* infest cornfields. Nut grass (*Cyperus rotundus*) with tuber-bearing underground shoots is especially frequent in gardens, where it is becoming very troublesome. Near Newbern it is considered the worst weed of the countryside. Bermuda grass (*Capriola dactylon*) is very common, and is in places a great nuisance in cultivated land.

Of waysides.—In the spring squirrel-tail grass (*Hordeum pusillum*) occupies almost every roadside, especially near the larger towns. The buttercup (*Ranunculus bulbosus*) covers pastures and waysides with a sheet of golden yellow. Peppergrass (*Lepidium virginicum*) is a common weed. The common garden honeysuckle (*Lonicera japonica*) is abundantly naturalized at roadsides, flowering profusely in May and filling the air with its fragrance. Vetches (*Vicia sativa*, *V. angustifolia*, *V. hirsuta*) are important elements of this part of the plant covering. A dock (*Rumex conglomeratus*) is common in roadside ditches. The wild onion (*Allium vineale*), chess (*Bromus secalinus*), and corn cockle (*Agrostemma githago*) are particularly conspicuous weeds toward the end of spring.

In early summer the wild carrot (*Daucus carota*) is in most places the predominant roadside weed. Round-leaved mint (*Mentha rotundifolia*) and fennel (*Foeniculum foeniculum*) are locally abundant in midsummer. The horse nettle (*Solanum carolinense*) and plantains (*Plantago rugelii* and *P. lanceolata*) are very common. Towards autumn native species gain the upper hand at most waysides; dog fennel (*Eupatorium capillifolium*), horseweed (*Erigeron canadensis*), rag weed (*Ambrosia artemisiaefolia*), knotweed (*Polygonum pennsylvanicum*), and sprouting crabgrass (*Panicum proliferum*) are most abundant; but such introduced species as Spanish needles (*Bidens bipinnata*), wormseed (*Chenopodium anthelminticum*), barn-yard grass (*Panicum crusgalli*), and yard grass (*Eleusine indica*) are also common. Bermuda grass (*Capriola dactylon*) is very common on country waysides, as well as along the streets and in the lawns of towns.

Ruderal plants.—These occupy waste ground in towns and about wharves, and the inclosures of country dwellings. Of course no sharp line divides this from the two preceding categories of weeds. Jimson weed (*Datura tatula*) is common, especially in barnyards and similar places. *Sagina decumbens* often grows between the bricks of city sidewalks. Lamb's quarters (*Chenopodium album*), wormseed (*C. anthelminticum*), and pigweed (*Amaranthus retroflexus* and *A. spinosus*), as well as other unsightly plants, occupy vacant lots. Vervain (*Verbena officinalis*), *Lycopus europaeus*, and low mallow (*Malva rotundifolia*) occur about wharves. In Newbern *Erigeron* *linearifolius* and the cosmopolitan tropical smut grass (*Sporobolus indicus*) are common street weeds.

ADAPTATION TO ENVIRONMENT IN THE NONHYGROPHILE INLAND VEGETATION—LIFE FORMS.

In the case of the group of formations just described little need be said in regard to adaptions to the environment. We are here dealing with what is, in a certain sense, neutral ground, lying between two different types of formation which have extreme life conditions, the Sand Strand on the one hand and the Hygrophile Forest on the other. Where the transition is toward the Sand Strand the vegetation possesses characteristics which have already been detailed under that heading. On the other hand, where conditions approach those prevailing in the Hygrophile Forest the plant covering becomes correspondingly modified, and the modifications can be most conveniently discussed in connection with that formation. Generally speaking, in the Wooded Plain conditions of soil and drainage vary greatly within such narrow limits, and most of the characteristic species show themselves to be so little choice in regard to habitat, that any attempt to discuss epharmonic modifications in the vegetation as a whole would be altogether unprofitable, even were it practicable. Very limited areas could be taken up in detail with a full description in each case of the physical conditions of the environment and the structure of the organisms forming the plant covering. Or, on the other hand, certain species of peculiar interest possessing well-marked epharmonic characters, e. g., *Senecio tomentosus*, *Ascyrum stans*, could be described at length. But neither mode of treatment would give a satisfactory idea of the ecology of the formation as a whole. It is more expedient to emphasize the heterogeneity of the formations of the Wooded Plain and to point out that the characteristics of the more xerophilous portions are similar to those already discussed under the heading of "Sand Strand," while the moist, low-lying areas exhibit the features which distinguish the forested swamps, to be described later on. It may be said, in a broad way, that the general aspect of the vegetation indicates exposure to a considerable degree of heat and light. These influences are largely counteracted, however, by the presence of abundant moisture in the air and soil, the absorption of water by the roots of plants being unhindered by the presence of any considerable quantity of sodium chloride, as in the maritime formations, or by that poverty of the soil in oxygen which distinguishes the swamps.

The nonpalustrine forest, as well as the drier portions of the wooded swamps, are exposed to forest fires, which occur at frequent intervals, especially in the autumn, and often sweep over considerable areas. However, the absence of a marked period of drought prevents this being an important factor in the life of plants, as is the case in other regions. No modifications of the plants that could be attributed to fire were observed in the Dismal Swamp region.[1] Forest fires are here sometimes accidental, but are often purposely started in order to produce in the following spring a more extensive development of young shoots of the cane (Arundinaria), which are eagerly grazed by cattle. The tendency of these fires is to destroy the older timber (especially the pines), and thereby effect a more vigorous shrubby growth. Certain herbaceous plants, notably the fireweed (*Erechtites hieracifolia*) and other Compositae, multiply rapidly upon land that has been ravaged by fire.

CLASSIFICATION OF LIANAS.

As nearly all the lianas, or climbing plants, both xerophilous and hygrophilous, which occur in the Dismal Swamp region are represented in the mixed forest formation of the Wooded Plain, there can be no better place than this for an enumeration of the species that possess this life form, so conspicuous and important in the region. The lianas may be classified[2] according to their mode of climbing, as follows:[3]

1. Clambering without development of local sensitiveness and not twining (Kletterpflanzen): in our two plants by means of hooked prickles:

* *Polygonum arifolium.*
* *P. sagittatum.*

2. Climbing by negatively heliotropic aerial roots:

Decumaria barbara.
Rhus radicans.
Tecoma radicans.

3. Twining:

* *Dioscorea villosa.*
* *Clitoria mariana.*
* *Bradburya* (*Centrosema*) *virginiana.*
* *Galactia volubilis.*
* *Falcata comosa* (*Amphicarpaea monoica*).
* *Apios apios* (*tuberosa*).
* *Rhynchosia tomentosa.*
* *Strophostyles helvola.*
Berchemia scandens (*volubilis*).
Gelsemium sempervirens.
* *Vincetoxicum* (*Gonolobus*) *carolinensis.*
Lonicera sempervirens.
* *Willughbaeya* (*Mikania*) *scandens.*

4. Climbing by tendrils, consisting of:

(*a*) Modified leaves—

Smilax spp.[4] (metamorphosed stipules).
Clematis crispa (metamorphosed petioles).
Bignonia crucigera (metamorphosed leaflets, ending in adhesive thickenings).

(*b*) Modified shoots—

Vitis spp.
Parthenocissus (*Ampelopsis*) *quinquefolia.*[5]
* *Melothria pendula.*
Ampelopsis arborea (*Cissus stans*).

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[1] Warming (Lagoa Santa, 250 to 263 and 466 to 469) describes the devastating fires to which the vegetation of the Brazilian "Campos" is exposed, and mentions certain important changes in the plant life of that region which he believes to have been brought about through the long-continued operation of this factor.

[2] The classification is that of Schenck, Beiträge zur Biologie und Anatomie der Lianen, I Theil, Biologie pp. 5 to 8, (1892).

[3] The names of herbaceous species are marked with an asterisk.

[4] Also mostly provided with hooked prickles.

[5] Tendrils ending in adhesive disks.

FRESH WATER FORMATIONS.

HYGROPHILE FOREST.

By far the greater part of the Hygrophile Forest of the region is embraced within the limits of the Great Dismal Swamp proper. That extensive morass has already been described, as to its physical characteristics, in the subdivision on geography and physiography, and the description need not be repeated in this place. As was there mentioned, certain smaller outlying tracts of swampy forest border the sluggish rivers which for the most part arise in the Great Dismal itself. There are also similar areas, of various size, scattered through parts of the region still more remote from the principal swamp, noteworthy being a considerable portion of "The Desert" at Cape Henry. The vegetation of these outlying swamps is very similar to that of the Great Dismal, and does not require to be separately treated.

Two principal formations are to be distinguished in the Hygrophile Forest: (1) The Black Gum or Dark swamp, covered with heavy deciduous forest; and (2) the Light, Open, or Juniper swamp, originally in great part covered with an evergreen forest of white cedar or "juniper" (*Chamaecyparis thyoides*), but now, in many places almost destitute of trees and bearing a growth of shrubs, of cane (*Arundinaria macrosperma*), and of ferns and peat moss. The first is in great part a virgin formation; the second, while composed entirely of indigenous species, owes its present condition largely to the work of man. Other associations, belonging to the fresh-water marsh and the aquatic formations, are subordinate elements in the plant covering of the swamps. They will be described under the formations to which they ecologically belong.

BLACK GUM SWAMP.

This, the local name of the heavy deciduous forest, indicates the predominance of the black gum (*Nyssa biflora*). (Plate LXVII.) The formation is also known in the region as "Dark swamp." Its larger trees are such as lose their foliage in the autumn, even the prevailing conifer, the bald cypress (*Taxodium distichum*), being deciduous. The only evergreen species among the large trees is the short-leaf pine (*Pinus taeda*), and that is comparatively scarce and unimportant. Such deciduous forest alone occupies the low, flat banks of the rivers above mentioned, and it is likewise characteristically developed within the Great Dismal Swamp proper, especially in the central portion about Lake Drummond. Fine tracts of it extend for 10 kilometers or more northwest of the lake, and cover large areas near the eastern periphery of the swamp. Indeed, areas occupied by this type of vegetation intervene between tracts of "Light swamp" in almost every part of the Great Dismal.

This is generally the wettest of the palustrine forest, and in no small part of it water 3 to 10 decimeters (1 to 3 feet) deep, or even more, stands upon the surface of the ground during a great part of the year. At all seasons the soil is nearly or quite saturated. Here organic matter accumulates upon the surface in enormous quantities, and we have, as Lesquereux pointed out, a living example of that process of coal formation which was so active in many parts of the globe during the Carboniferous period.[1] On the eastern margin of Lake Drummond the stratum of black, spongy humus is at least 3 meters (10 feet) deep, and perhaps considerably more. Underlying these deposits are beds of sand and silt, often containing great numbers of fossil marine shells, probably of Pliocene age.[2]

The most abundant tree of the deciduous forest is probably the black gum (*Nyssa biflora*), although the red maple (*Acer rubrum*) is almost equally so. This maple seems to be increasing in the swamps more rapidly than any other tree, as thousands of its seedlings cover the ground wherever there is no standing water. Cypress (*Taxodium distichum*), while still fairly abundant in parts of the swamp, was formerly much more so. Especially at the margin of Lake Drummond, a belt of old cypress stumps, many of great size, is evidence of what must once have been a fine forest of this tree (fig. 56). The value of the wood of the cypress, which has been assiduously sought after in the swamp for a hundred years or more, is responsible for its present relative scarcity. Taxodium reproduces itself very slowly, so that an area once gleaned for merchantable timber is regarded by lumbermen as permanently exhausted. Except upon small tracts of marshy land at the edge of Lake Drummond, where seedlings are quite plentiful,[3] there is very little evidence that this tree will regain its former importance in the Dismal Swamp. Nevertheless, it is still the largest tree of the region, specimens 35 meters (120 feet) high and 12 or even 15 decimeters (4 or 5 feet) in diameter above the swollen base being not infrequent.

The black gum (*Nyssa biflora*) is often nearly as tall (sometimes 30 meters, 100 feet), but smaller, usually 3 to 6 decimeters (1 to 2 feet) through above the enlarged base. Red maple (*Acer rubrum*) grows to a height of 20 to 25 meters (70 to 80 feet), but the trees are almost always small, not much exceeding 3 decimeters (1 foot) in diameter. In many parts of the swamp cotton gum (*Nyssa uniflora*), locally known as papaw gum, is plentiful, but is not nearly so large a tree as *N. biflora*. It is a very characteristic plant, however, with its large leaves and fruits, and is one of the first trees of the swamp to lose its leaves in autumn. Seedlings of both species of Nyssa are abundant about Lake Drummond. *Pinus taeda* is occasional, especially on higher lands near the eastern border of the swamp. One tree observed in the heart of the morass, however, was growing where it was surrounded by water 3 decimeters (1 foot) deep, which almost touched its base, yet it was perfectly healthy and of good size, about 25 meters (80 feet) high and nearly 5 decimeters (1½ feet) in diameter.[1] The water ash (*Fraxinus caroliniana*) is rather abundant as a slender tree, the largest specimen seen being about 25 meters (80 feet) high and 6 decimeters (2 feet) in diameter near the base.

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[1] Lesquereux. Torfbildung im grossen Dismal Swamp; Zeitschr. der deutsche geologische Gesellch., vol. 4. pp. 695 to 697.

[2] Shaler, Tenth Ann. Rept. U. S. Geol. Surv., p. 315 (1890).

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Among the less important of the larger trees should be mentioned the willow oak (*Quercus phellos*), which is occasional in the wettest parts. One fine specimen observed was about 23 meters (75 feet) high.

Among small trees *Magnolia virginiana* and *Persea pubescens*, both locally known as "bay," are abundant, especially about Lake Drummond, at the edges of clearings. The two species are much alike in habit, having usually slender crooked stems 6 to 9 meters (20 to 30 feet) high. The largest magnolia observed was about 18 meters (60 feet) high and 4½ decimeters (1½ feet) in diameter, with the stocky habit often assumed by *Ilex opaca*. Blue beech (*Carpinus caroliniana*), black willow (*Salix nigra*), and black alder (*Alnus rugosa*) are rather common near Lake Drummond, but hardly attain the size of trees. The same may be said of *Populus heterophylla*, which is frequent in the smaller swamps along streams, and rarely grows to be more than 5 meters (16 feet) high.

Near the eastern border of the Dismal Swamp, where *Pinus taeda* is most abundant, the tulip tree (*Liriodendron tulipifera*) and the sweet gum (*Liquidambar styraciflua*), occur in the deciduous-forested swamp, and are often of considerable size.

In typical areas of this deciduous or "black gum" forest the trees stand closely together and the shade is dense. This, and the usual presence of standing water, accounts for the absence or scarcity in many places of the smaller forms of terrestrial vegetation, which often find a substratum suitable to their growth only in the limited accumulations of humus about tree stumps and old logs. The trunks of most of the trees are very straight, usually small in diameter, and of almost uniform girth and destitute of branches for two-thirds or more of their small part of it water 3 to 10 decimeters (1 to 3 feet) deep, or even more, stands upon the surface of the ground during a great part of the year. At all seasons the soil is nearly or quite saturated. Here organic matter accumulates upon the surface in enormous quantities, and we have, as Lesquereux pointed out, a living example of that process of coal formation which was so active in many parts of the globe during the Carboniferous period.[1] On the eastern margin of Lake Drummond the stratum of black, spongy humus is at least 3 meters (10 feet) deep, and perhaps considerably more. Underlying these deposits are beds of sand and silt, often containing great numbers of fossil marine shells, probably of Pliocene age.[2]

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[1] The adaptability of this species is somewhat remarkable. It seems equally at home in almost every soil of the region, making a good growth even among the open dunes. According to Shaler, it is most abundant in the Dismal Swamp on land that is slightly (1 meter or less) higher than the lowest adjacent area. Shortly after the civil war a considerable quantity of pine timber was removed from the eastern part of the swamp, and was used for masts and spars of naval vessels. Logs 6 meters (20 feet) long, 9 decimeters through at the butt, and 6 decimeters at the tip were thus obtained.

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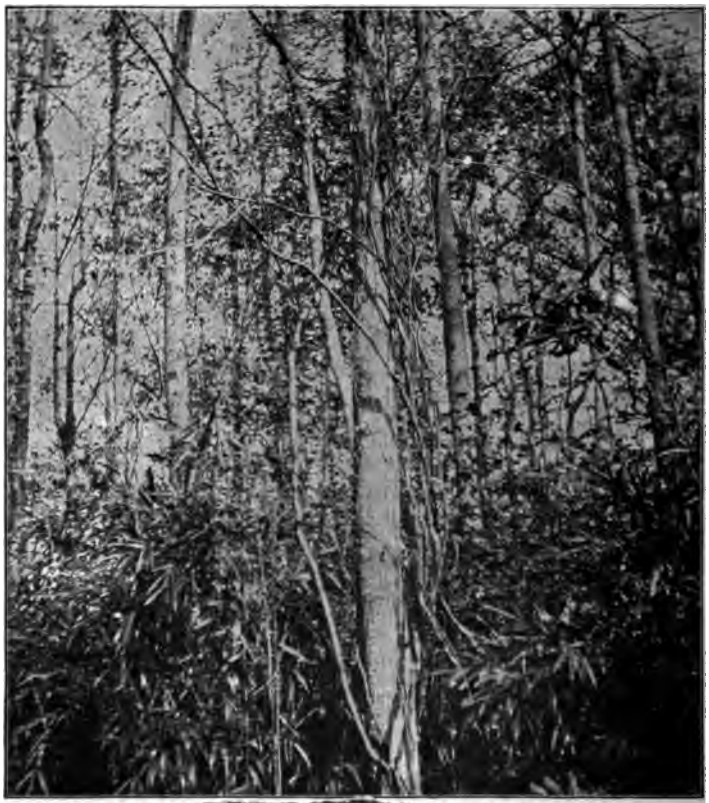

FIG. 78.—Rattan (*Berchemia scandens*) climbing on trees in the Black Gum swamp.

No less conspicuous are the numerous, large, often intertwined stems of woody lianas, that embrace the trunks and climb often to the treetops (fig. 78). Most abundant and characteristic are the supple-jack or "rattan" (*Berchemia scandens*), yellow jessamine (*Gelsemium sempervirens*), cross vine (*Bignonia crucigera*), and muscadine grape

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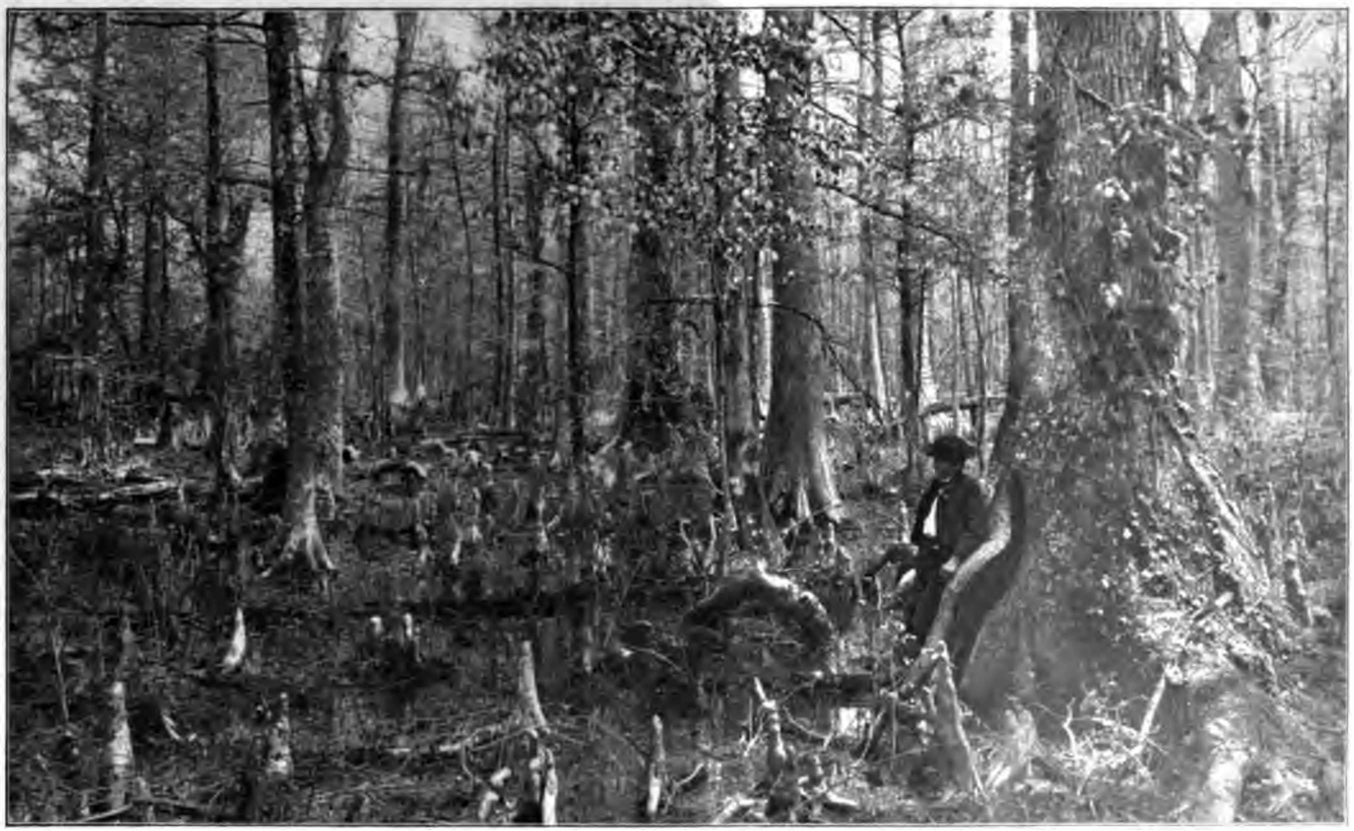
[1] The most remarkable individual owes to this peculiarity its local designation of "Samson's Maul."



BLACK GUM SWAMP, SHOWING KNEES OF THE CYPRESS (TAXODIUM) AND ARCHED ROOTS OF THE BLACK GUM (NYSSA [illegible]).

(*Vitis rotundifolia*), which climb by twining (the young stems and branches of the two latter with the aid of tendrils); and *Decumaria barbara* and the poison ivy (*Rhus radicans*), which hold fast to the bark by means of innumerable aerial roots (Pl. LXX). In spring the fragrant bright yellow campanulate blossoms of Gelsemium and the large trumpets, dusky red outside, orange-colored within, of Bignonia are produced in great profusion among the crowns of the trees. In early summer Decumaria puts forth numerous cymose clusters of small white flowers. Less common are *Vitis labrusca*, *Smilax rotundifolia*, and *S. walteri*, the latter quite conspicuous when its scarlet fruits are mature. *Smilax laurifolia*, abundant in the open swamp, occurs only on the edges of the black gum forest, being decidedly a sun-loving plant. *Clematis crispa*, with handsome, lilac-purple flowers, and the ground nut, *Apios apios*,[1] are frequent, but are not to be classed among the larger woody lianas. The former has weak, thin stems with a comparatively slight development of wood, while the latter is a perennial twining herb. Farther south, near Newbern, *Ampelopsis arborea* is a common liana of the wooded swamps.

In every direction the ground is encumbered with old logs and stumps in all stages of decomposition. Upon these is the favorite haunt of saprophytic fungi, as well as of small phanerogams such as *Tipularia unifolia*, *Habenaria clavellata*, *Gaultheria procumbens*, and *Mitchella repens*. Liverworts and mosses are likewise abundant on dead stumps and upon the bases of living trees. The smooth, light-gray bark of the red maple affords a home to numerous Bryophyta. A woody parasite, the mistletoe (*Phoradendron flavescens*), is abundant upon the branches of *Nyssa biflora* and *Acer rubrum*, especially around Lake Drummond, where in the spring its dark leaves contrast strikingly with the tender green of the young foliage of the host trees (fig. 79). Occasionally it grows upon the main trunk of small red maples, sometimes at a height of only 1 meter (3 feet) from the ground.

Two vascular epiphytes, besides numerous lichens, make their home upon the branches of Taxodium, especially on the margin of the lake and other open places, where light is plentiful. These are a fern, *Polypodium polypodioides* (*incanum*), and a phanerogam, Spanish moss (*Tillandsia usneoides*). The latter was noticed only upon the small cypress trees in Lake Drummond (Plate LXVIII), where it is rather scarce, and none was seen with stems over a half meter (1½ feet) long.[2]

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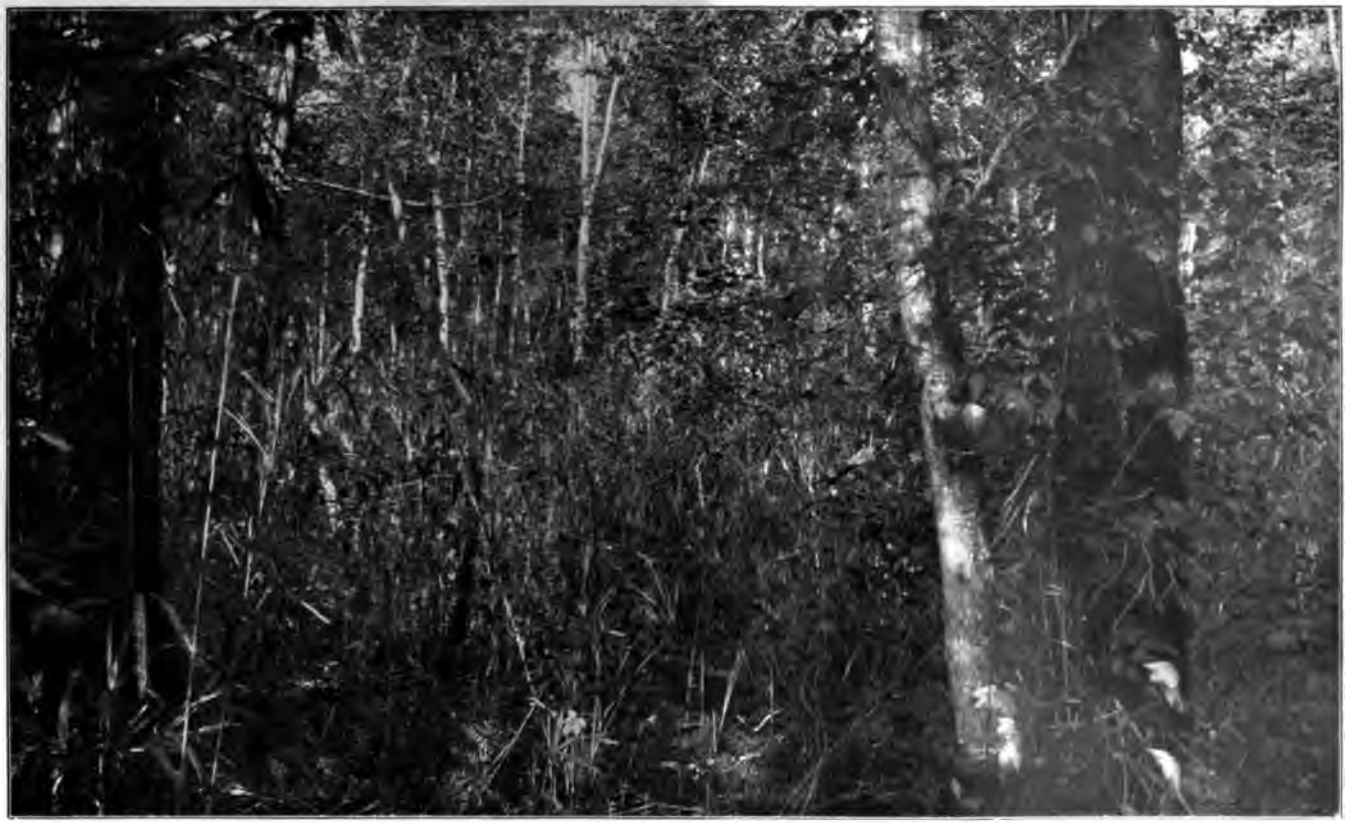
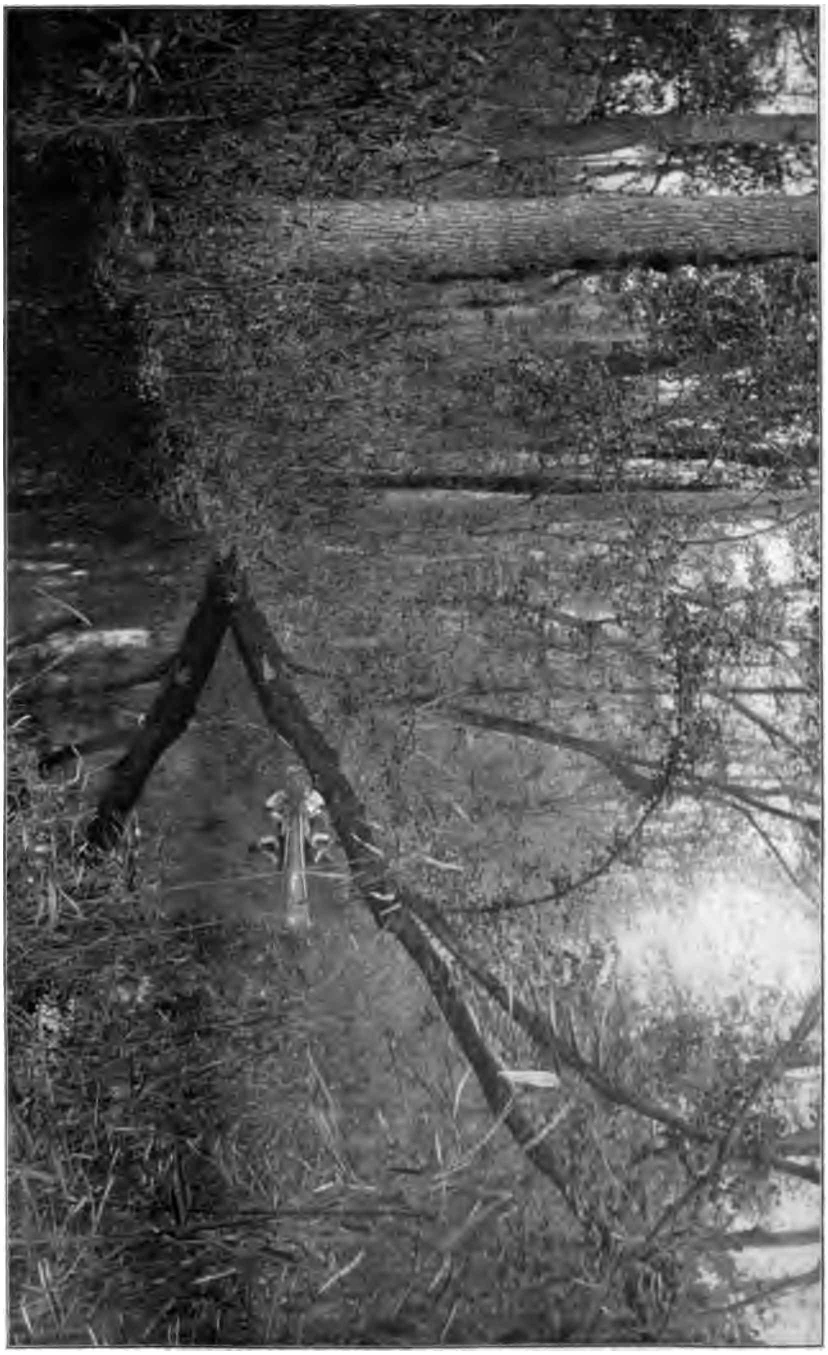
[1] The one species of the Leguminosae which can be said to be thoroughly at home in the Dismal Swamp.

[2] On Long Creek, near Cape Henry, *Tillandsia usneoides* grows to a length of 4 feet. This plant must formerly have been common in the region, to judge from a remark of Colonel Byrd in the "Westover Manuscript," where, speaking of the trees near the Dismal Swamp, he writes that they "looked very reverend, with the long moss that hung dangling from the branches. Both cattle and horses eat this moss greedily in winter when other provender is scarce, though it is apt to scour them at first."



POISON IVY (RHUS RADICANS) IN BLACK GUM SWAMP, ON THE RIGHT; CANE (ARUNDINARIA MACROSPERMA) AND OSMUNDA REGALIS, FOREGROUND.

PLATE LXXI.



BIG CANE (ARUNDINARIA MACROSPERMA ALONG A DITCH IN BLACK GUM FOREST.

abundance of individuals, however, this plant is most important in the lighter parts of the Juniper swamp.

In some parts of the deciduous or Black Gum forest ferns are abundant, especially *Woodwardia areolata*, *Osmunda regalis*, and *O. cinnamomea*. The lizard's tail (*Saururus cernuus*) is plentiful.

The most extensive herbaceous growth observed in any part of this formation covers a limited area upon the eastern shore of Lake Drummond, where the ground is rather high, firm under foot, and devoid of standing water, at least during the summer. Here the rich, black humus, containing only 6 per cent of inorganic matter, is at least 3 meters (10 feet) deep and bears an herbaceous growth such as is often seen in alluvial forests farther north. Besides a vast number of seedlings of *Acer rubrum*, the following perennial herbs are abundant: *Saururus cernuus*, *Boehmeria cylindrica*, *Polygonum arifolium*, *Scutellaria lateriflora*, *Aster diffusus*, *Lycopus rubellus*, *Eupatorium purpureum*, *Impatiens biflora*, and *Woodwardia areolata*.

OPEN OR LIGHT SWAMP.

Juniper forest association.—This formation, usually known locally as "Juniper swamp," is most characteristically developed in the peripheral portions of the Great Dismal and does not extend beyond the limits of the main swamp. On the eastern margin, near the source of the Northwest River, is a typical body of such forest. The prevailing tree is the white cedar (*Chamaecyparis thyoides*), known by the inhabitants of the region as "juniper" (fig. 80). On account of the commercial value of its wood, great numbers of the trees have been removed, and those which remain are mostly small. In places they still form tracts of dense forest, but more often the trees are scattered or mixed with other species. Indeed, extensive areas formerly covered with juniper forest are now almost entirely destitute of trees, and are occupied by woody undergrowth, or even largely by herbaceous plants. Such lands are particularly subject to fires, which effectually prevent the renewal of the forest.

The "Juniper swamp" is usually not so wet as the "Black Gum swamp," yet large areas of it, especially along the Dismal Swamp Canal, are under 3 to 6 decimeters (1 or 2 feet) of standing water even in midsummer. Without doubt this condition of things is partly due to artificial causes. According to Professor Shaler, Chamaecyparis is most at home in parts of the Great Dismal that are subject to partial desiccation at some period of the year.

The substratum in the Juniper swamp consists of a red-brown peat composed largely of the stems, leaves, and roots of the Chamaecyparis, and often containing, to a considerable depth, stumps and logs in a remarkably well-preserved condition. This peat often extends to a depth of 3 meters (10 feet) and usually contains small traces of sand.

opaca), and even small red maples (*Acer rubrum*) and black gums (*Nyssa biflora*) are often present. The cotton gum (*Nyssa aquatica*) is abundant in some parts of the Open swamp, as a small tree 6 meters (20 feet) or so high. On somewhat higher and drier land, oaks (*Q. nigra*, *Q. michauxii*), beech (*Fagus americana*), and other trees invade what was originally juniper forest.

Ericaceae (*shrub*) *association.*—Very abundant and important in the light swamp, especially in the more open places where most of the trees have been removed, is an association of shrubs in which Ericaceae largely predominate (Pl. LXXII). The more important species, named approximately in the order of their abundance, are: *Clethra alnifolia*, *Itea virginica*, *Xolisma* (*Andromeda*) *foliosiflora*, *Leucothoë racemosa*, *Pieris* (*Andromeda*) *nitida*, *Ilex glabra*, *Azalea viscosa*, and *Vaccinium corymbosum*. Frequent, but not usually abundant, are *Viburnum nudum*, *Ilex lucida*, *I. decidua*, *Aronia* (*Pyrus*) *arbutifolia*, and *Amelanchier botryapium*. *Kalmia angustifolia* is somewhat rare and *Leucothoë axillaris* appears to be less at home here than in the black gum forest. *Rhus vernix* (*venenata*) and *Rosa carolina*, which are abundant in the lesser swamps of the region, are of small importance within the borders of the Great Dismal proper.

These shrubs often grow so densely as to exclude almost all other vegetation, usually to a height of 1 to 2½ meters (4 to 8 feet), but with larger individuals here and there which are 5 meters (15 feet) or so high. The stems are usually very crooked and the branches numerous. Most of the species are deciduous-leaved, but two of the most common, *Pieris nitida* and *Ilex glabra*, have thick, shining, evergreen leaves, a character likewise possessed by the less common *Ilex lucida* and *Leucothoë axillaris*. Almost all of these species have showy clusters of white flowers. Those of Itea, Leucothoë, Azalea, and Pieris appear in May, while Clethra is in full blossom in midsummer. The flowers of *Azalea viscosa*, *Leucothoë axillaris*, and *Clethra alnifolia* are very fragrant. This woody undergrowth is especially well developed along the ditches and in clearings. It is an association which is rapidly increasing in the interior of the Dismal Swamp, where it is said to have been once almost unknown.

Occurring primarily as a constituent of the shrub association is the exceedingly abundant *Smilax laurifolia*, one of the most conspicuous and characteristic plants of the region. This vigorous liana forms great masses among the undergrowth, bearing down the supporting plant by the weight of its heavy wood, thick leaves, and abundant fruit. It is a handsome plant, with evergreen leaves of the laurel type. A striking contrast is afforded by the colors of the leaves of different age—light, almost pea-green, when young, dark and shining when older. The young plants and young branches ascend by means gion, and suggests the great coniferous forests of northwestern nerica rather than the southern coastal swamps in which it is at me.

Juniper, unlike cypress, ordinarily reproduces quite rapidly, so that om some tracts of this forest in the Dismal Swamp three cuttings the merchantable timber have been made with profit within twenty ars. The wood is said to increase in thickness about 2½ centimeters inch) per year. Despite its rapid growth and tendency to spread, equent fires prevent a material increase of the area occupied by this e.

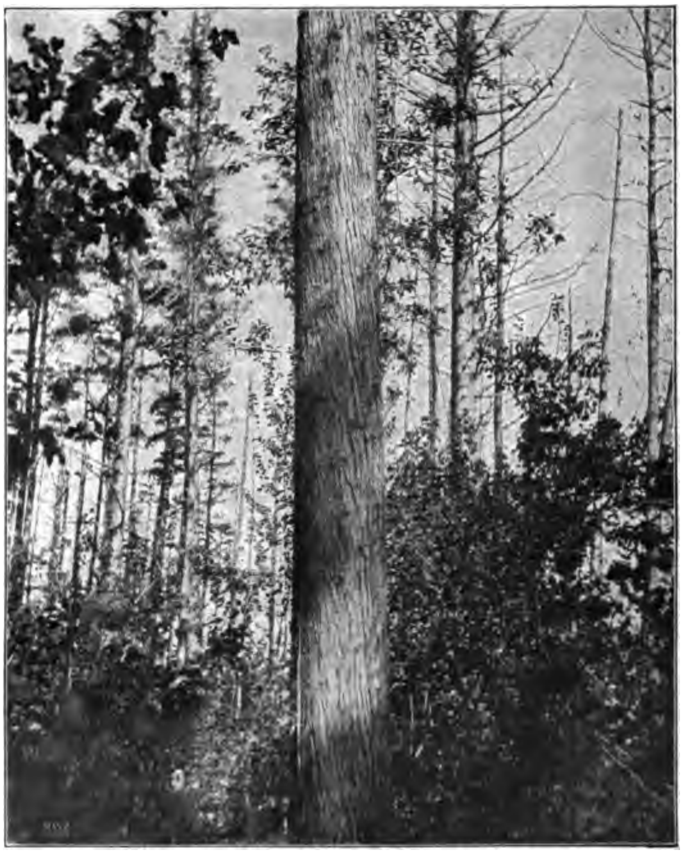


FIG. 81.—Trunk of "juniper" (*Chamaecyparis thyoides*).

As above stated, where the juniper has been left undisturbed it ows in nearly pure association. Where much of it has been removed the woodman, however, other trees appear. Notable among these the loblolly pine (*Pinus taeda*), which is almost always associated th the juniper, usually as a small tree of about the same size. e sweet bay (*Magnolia virginiana*), *Persea pubescens*, holly (*Ilex* *opaca*), and even small red maples (*Acer rubrum*) and black gums (*Nyssa biflora*) are often present. The cotton gum (*Nyssa aquatica*) is abundant in some parts of the Open swamp, as a small tree 6 meters (20 feet) or so high. On somewhat higher and drier land, oaks (*Q. nigra*, *Q. michauxii*), beech (*Fagus americana*), and other trees invade what was originally juniper forest.

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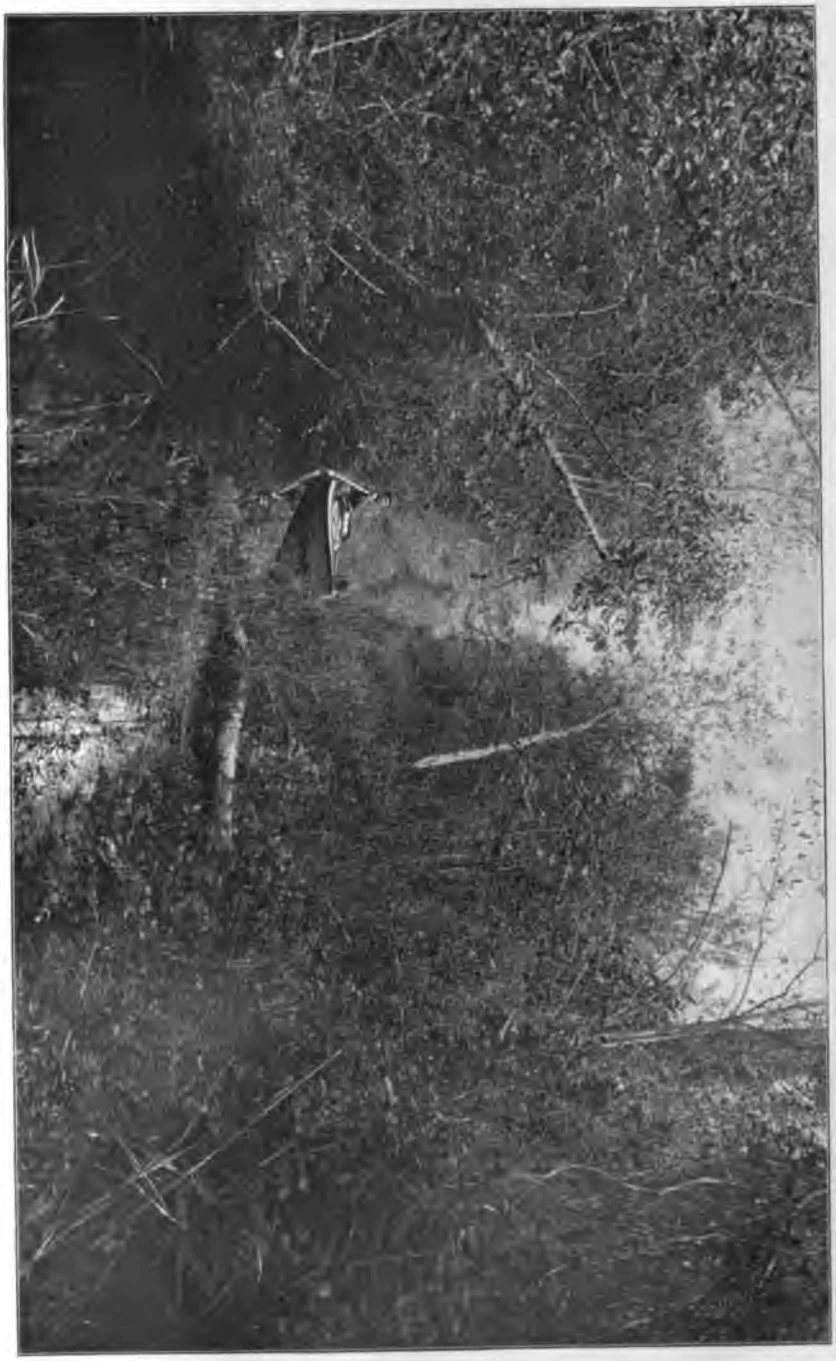

Association of Shrubs and small Trees along Ditches in the "Light Swamp."

of tendrils, while the older stems twine about supporting objects. In consonance with the strongly xerophilous structure and aspect of this plant is its marked preference for the open, sunny parts of the swamps. It also occurs at the edges of the Black Gum swamp, and often ascends small trees.

Less abundant, but quite conspicuous when its scarlet fruits are ripe, is a species of greenbrier with deciduous leaves, *Smilax walteri*, which, however, shows a greater liking for shade than does *S. laurifolia*.

Arundinaria macrosperma (*Canebrake*) *association.*—No less important in the open parts of the swamp than the association just described is the "canebrake," which covers extensive areas, often in nearly pure association, where the shrubby growth has not secured the upper hand. The cane (*Arundinaria macrosperma*), a woody, bamboo-like grass, locally known as "reeds," grows usually to a height of 2 meters (over 6 feet), although, especially along the ditches and at the edges of woods, it is not rarely 4½ meters (15 feet) high (fig. 82). Along the water courses the aspect of the plant is peculiarly

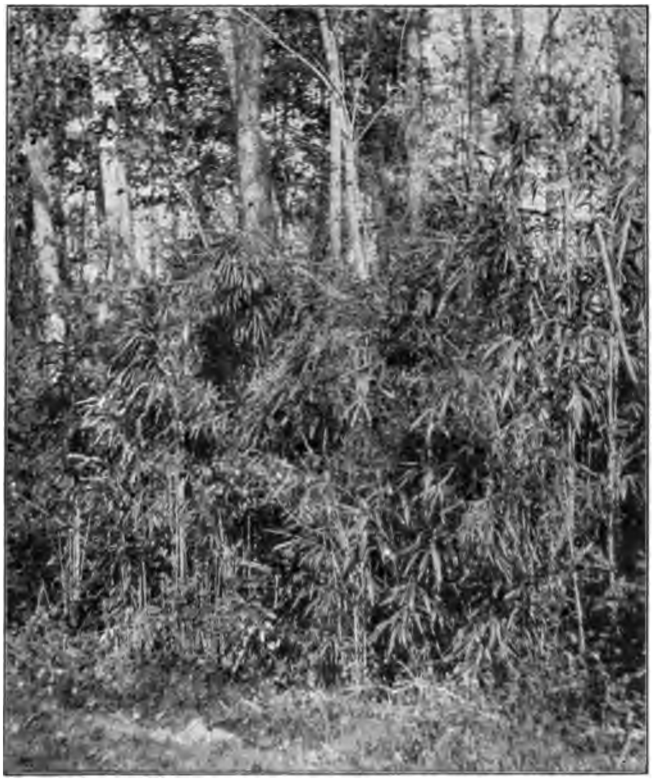

FIG. 82.—Big cane (*Arundinaria macrosperma*).

attractive, with its stems and leaves bending in graceful curves, especially after a heavy rain. In the wetter parts of the swamp the cane forms small hummocks, with its culms often standing so closely together that it is difficult to insert a finger between them. In such cases the dead leaves, as they fall, accumulate among the stems, often to a height of 3 decimeters (1 foot) or more; and, as the strong woody root stocks form a dense sod, one can readily believe that this plant, next to the trees and larger shrubs, is the most effective contributor to the sum total of dead organic matter which year by year accumulates upon the surface of the swamp. Arundinaria spreads rapidly by means of its creeping, much-branched underground stems, so that in land recently reclaimed from the swamps and not thoroughly drained it is sometimes a serious pest.

Woodwardia-Sphagnum (*Fern and Peat Moss*) *association.*—The more open parts of the wooded swamp are not always occupied by Arundinaria or other woody undergrowth. Occasionally a large fern, *Woodwardia virginica*, predominates, growing usually upon low hummocks surrounded by standing water. The fronds often measure more than 12 decimeters (4 feet) from the base of the stipe.[1] Other species often associated with the fern are *Eriophorum virginicum*, *Decodon verticillatus*, a suffrutescent lythraceous plant with curving, whip-like stems that strike root and develop aerenchyma where they touch the ground or water, and a handsome orchid, *Limodorum tuberosum*, which here grows to remarkably large size.

Among the stipes of the Woodwardia, and especially in the shallow water on the margins of the hummocks, a species of peat moss (*Sphagnum cymbifolium glaucescens* and its form *squarrulosa*) is abundant. This plant usually has its basal portion submerged, but with a considerable length of the stem rising above the surface of the water. The longest stems observed were about 4½ decimeters (1½ feet), although 15 centimeters (6 inches), or even less, is a more common length. Peat mosses can not be regarded as very important humus-builders in this region, although their value in this regard has been somewhat underestimated. Nowhere are to be seen areas of any considerable size covered with a continuous growth of Sphagnum. Except in some of the ditches of the swamp,[2] these mosses are always secondary members of associations. Of course nothing analogous to the "climbing bogs" and no supplanting of the tree growth by Sphagnum has been observed in the region of the Dismal Swamp. On the contrary, these mosses can make little headway until the forest has been removed or thinned by artificial means. They do not thrive in the shade of the Black Gum forest, nor are they common where Arundinaria is most abundant.[1]

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[1] For an interesting observation that would indicate positive heliotropism in the fronds see W. Palmer in Proc. Biol. Soc. Washington, vol 13, p. 68 (1899).

[2] See under "Aquatic Vegetation," p. 445.

In the swampy woods that border streams a few kilometers west of the main body of the Great Dismal Swamp a number of species enter into the Black Gum forest association that were not observed farther east. The tree growth remains the same; but, among shrubs, the fringe tree (*Chionanthus virginica*), cornel (*Cornus candidissima*), elder (*Sambucus canadensis*), and *Viburnum dentatum* are common. *Lilium superbum* on hummocks and old stumps grows to a height of nearly 2 meters (6 feet). Less frequent is *Habenaria cristata* with small flowers of a brilliant orange color.

Along brooks, especially when flowing through cleared land, occur small specimens of a number of trees that are comparatively rare or altogether wanting in the large wooded swamps. Noteworthy are the buttonwood (*Platanus occidentalis*), black cherry (*Prunus serotina*), and *Catalpa bignonioides*, associated with small examples of cypress (Taxodium), red maple (*Acer rubrum*), and other species common in the palustrine forest.

ADAPTATIONS TO ENVIRONMENT IN THE HYGROPHILE FOREST—LIFE FORMS.

An analysis of the physical environment that prevails in this type of forest leads to the segregation of certain factors which are known to be of primary importance in their influence upon plant life:

1. High temperatures during at least six months of the year, a comparatively mild winter, and, consequently, a long growing season.
2. Strong light during a great part of the growing season, the annual percentage and number of hours of sunshine being relatively high.
3. Abundant atmospheric humidity and a heavy rainfall, fairly equably distributed throughout the year.
4. Absence of exposure, for the most part, to strong winds.
5. Soil very wet, usually saturated, often covered with 3 decimeters (1 foot) or more of standing water; cold; poor in oxygen; more or less acid; exceedingly rich in partially decomposed organic matter.

To the soil conditions all the vegetation, save the epiphytic and parasitic forms, is directly subject. Likewise the high temperatures which prevail for many months in the region must affect all plants, but, of course, those that grow in the shade much less than those exposed to the direct sunlight. On the other hand, exposure to strong light is experienced in the deep forest only by the large trees, but in the more open parts also by smaller plants.[1] This exposure to strong light and much heat is partially responsible for certain characteristics of the leaves of woody plants in the Dismal Swamp, which can be interpreted as affording protection against excessive transpiration (possibly also against the injurious effect upon the chlorophyll of too intense light). Peculiarities of swamp soil which are well known to cause a lowering of the absorbing action of roots, and hence to reduce the plant's water supply, are probably still more important causes of such modifications, which are thus serviceable in compensating the restricted absorption of water by diminishing the quantity that is transpired by the leaf surfaces. These qualities of the soil are coldness, poverty in oxygen, and acidity, and to them we must ascribe the seeming anomaly that plants growing in shade in wet forests may possess certain peculiarities of structure which are generally known as xerophytic, and are likewise developed, albeit to a much higher degree, in plants of the most arid and sun-baked deserts.[2] In other words, as has been well expressed by Schimper,[3] a physically very wet soil is not necessarily physiologically wet, for the amount of water which the roots can take up is by no means always proportionate to the amount present in the substratum.

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[1] Lesquereux, in a paper entitled "Torfbildung im grossen Dismal Swamp," published in Zeitschr. der deutschen geolog. Gesellsch., vol. 4, pp. 695 to 697 (1852), ascribes a much greater importance to Sphagnum in the Dismal Swamp than it really possesses. He writes of the vegetation as "consisting, as in Switzerland, chiefly of Sphagnum, of which, besides European species, there occur several which are peculiar to this continent." This author is surely in error when he interprets the swamp, with its central lake, as an example of "that lacustrine peat formation which occurs in the great bogs of Scandinavia and Denmark." There, he states, "whenever the covering which overlies the underground lake becomes too heavy it sinks easily and gradually, first in the middle and then toward the periphery." We have no evidence that Lake Drummond was produced in any such way.

ADAPTATIONS TO REDUCE TRANSPIRATION.

An examination of the leaves of the woody plants which occur in the Dismal Swamp shows that almost every species is in some way equipped to reduce the amount of transpiration. Adaptations of the following kinds may be mentioned:

1. *Position and general structure of the leaf.*—In only one species, the parasitic *Phoradendron flavescens*, were the leaves found to be isolateral in structure and orthotropic (approximately vertical, or, in other words, parallel to the direction of the light rays) in position. It goes without saying that we have here an excellent protection against excessive loss of water.[4] All other species examined (except-

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[1] To the intensity in this region of the light and heat rays of the sun, anyone who has been on Lake Drummond in a boat at noon on a midsummer day can testify. Only on the sand dunes does one's skin burn more quickly and fiercely.

[2] The existence in the Hygrophile forest of conditions of environment which induce xerophytic characters in vegetation, may account for the presence there of *Pinus taeda*, which is most abundant in the drier parts of the nonhygrophile forest, and flourishes even amid the sand dunes. The converse fact that the bald cypress (Taxodium) can be grown successfully when transplanted to a well-drained upland soil is perhaps to be explained in the same way.

[3] Pflanzengeographie, p. 4.

[4] Moreover, the leaf of Phoradendron is very thick, indeed succulent, and the cuticle is quite massive.

ing *Smilax walteri*), have leaves that are strongly bifacial (dorsiventral) as to structure, and plagiotropic in position, i. e., approximately horizontal, and thus receiving the incident rays as nearly as may be at a right angle. As has already been mentioned, in discussing adaptations to environment in the Sand Strand, leaves thus constituted and placed, unless shaded by other plants or objects from the direct rays of the sun, may have their structure modified in various ways so as to reduce the amount of water transpired, while some of the modifications may serve likewise to shield the sensitive chloroplasts from the injury and even decomposition caused by excess of light. Consequently we find the following arrangements.

2. *Position of the stomata.*—In all the species examined (excepting Phoradendron and *Smilax walteri*, the latter to a certain extent shade-loving) the stomata occur exclusively on the lower (dorsal) leaf surface, and are thus protected by the whole thickness of its tissues from the direct light and heat rays. The stomata of *Smilax laurifolia* are further protected by being deeply sunken, the entire thickness of the massive cuticle lying above the guard cells, while exchange of gases with the outer air is permitted only by a narrow canal through the cuticle.

3. *Epidermal outgrowths.*—The lower surface of the leaf is protected in some species by outgrowths of the epidermis.

(*a*) Hairs, which soon lose their living contents and become filled with air. These are in some cases sufficiently numerous to form a close, downy covering on the under surface of the leaves, especially when young.[1] They occur in the following species: *Persea pubescens*, *Acer rubrum* var., *Magnolia virginiana*, *Nyssa uniflora*. This hairy covering, by forming spaces between the hairs and the leaf surface which are not readily accessible to atmospheric currents, undoubtedly assists in reducing the quantity of vapor of water transpired from the leaf. It may also help to keep the leaf surface free from rain water, which would otherwise cover the mouths of the stomata at times and hinder the entrance and exit of gases. A number of species with persistent, leathery leaves, i. e., *Ilex glabra*, *I. lucida*, *Leucothoë axillaris*, have scattered, prickle-like hairs, which are confined to the impressed larger veins on the ventral surface of the mature leaf.

(*b*) A coating of wax, giving the leaf surface a glaucous appearance. This occurs in *Acer rubrum*,[2] *Magnolia virginiana*, *Persea pubescens*, *Rosa carolina*, *Kalmia angustifolia*. In *Berchemia scandens* the cuticle of both surfaces of the strongly ombrophobic (water shedding) leaf is granular-roughened, probably with a slight deposit of wax. Waxy incrustations prevent such transpiration from the general surface of the leaf as normally takes place in addition to that from the stomatal pores, and which, while relatively slight, amounts in the total to a considerable quantity. Moreover wax, even more effectually than a covering of hairs, prevents rain water from standing upon the leaf surface. A glaucous leaf, in other words, "sheds water."[1]

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[1] In very young leaves the upper surface also is protected.

[2] The red maple when growing in sunny situations, as on the margin of Lake Drummond, has a thickish leaf, with dark green, shining upper surface, and a very glaucous, usually more or less pubescent, dorsal surface. In deep shade the leaf is thin, and merely pale or only slightly glaucous, usually not pubescent beneath when mature.

4. *Strong secondary thickening of the cuticle and outer walls of the epidermis cells.*—The leaves of almost all the woody plants of this formation which were examined exhibit such thickening, especially upon the more exposed upper (ventral) surface. This is particularly evident in the rather numerous species with thick, coriaceous, persistent leaves, e. g., *Pieris nitida*, *Leucothoë axillaris*, *Ilex opaca*, *I. lucida*, *I. glabra*, *Gelsemium sempervirens*, *Magnolia virginiana*, *Smilax laurifolia*. The possible advantages of the polished, shining upper surface of these leaves were discussed in relation to certain species of the Sand Strand. Wiesner has advanced the theory that they serve to reflect some of the incident light.

In a number of species the cuticle is roughened; wrinkled in *Smilax laurifolia*, *Leucothoë axillaris*, *Pieris nitida*, *Xolisma foliosiflora*, and *Chionanthus virginica*; granular in *Berchemia scandens*. In the first three of the species with wrinkled cuticle the ridges are stronger on the lower (dorsal) surface; in the last two, on the upper (ventral) surface. As the leaves of all these species are plagiotropic with ventral surface upward, this difference seems unaccountable. It has already been mentioned that such unevennesses on the surface of the cuticle are believed to refract part of the light, and hence to diminish the intensity of its action upon the tissues below.

5. *Mucilage in the cells of the epidermis.*—This occurs in *Berchemia scandens*, and may aid in preventing the too rapid escape of water from the leaf.[2]

6. *Hypoderm.*—A continuous hypoderm, of one layer of cells, lies beneath the ventral epidermis in the leaves of *Pieris nitida*. Its func-

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[1] Equally effective in preventing the accumulation of water on the surface of the leaf is a dense covering of papillae, such as occurs on the upper surface of the floating leaves of some aquatics and is not rarely present in ombrophobic, shade-loving plants, especially in the tropics. Ombrophobic leaves are injured by long-continued exposure to rains or immersion in water, while this is not the case with foliage that is ombrophilous. Ombrophobic leaves are almost always possessed by xerophilous plants, while of plants that are hygrophilous some have ombrophilous, others ombrophobic foliage. "Largely speaking one can regard the 'unwetableness' of the leaf as a sign that it is ombrophobic; 'wetableness' as an indication that it is ombrophilous." Wiesner, Sitzungsber. der K. Acad. zu Wien, Math.-Naturw. Classe, vol. 102, Abth. 1, pp. 503 to 521 (1893); and vol. 103, Abth. 1, pp. 169 to 191 (1894).

[2] Volkens, Flora der ägypt. arab. Wüste, pp. 43-45, discusses this question at some length, and suggests the above-mentioned as the probable advantage of mucilage in the epidermis cells.

tion is in all probability the protection of the chlorophyll tissue proper against the effect of too much heat and light by removing it thus much farther from the surface of the leaf.

7. *Palisade.*—The value of palisade tissue in reducing transpiration was discussed under "Adaptations to Environment in the Strand Vegetation."[1] It is rather strongly developed in the following plants of the Dismal Swamp: *Smilax laurifolia* (2 layers), *Magnolia virginiana* (2 layers), *Persea pubescens* (2 layers), *Liquidambar styraciflua* (2 layers), *Ilex glabra* (4 layers), *Ilex lucida* (3 layers), *Acer rubrum* var. (only one layer, but the cells are so high as to form more than one-half the thickness of the mesophyll), *Leucothoë axillaris* (2 layers), *Leucothoë racemosa* (2 layers), *Kalmia angustifolia* (2 layers), *Gelsemium sempervirens* (3 layers, but only the uppermost very compact).

AERATING ADAPTATIONS.

Passing now to other epharmonic characters of the vegetation in the Hygrophile forest formation, we encounter some very interesting modifications of structure in certain of the swamp trees which are believed to have as their function the furnishing of air to the roots, which lie in a substratum unusually poor in oxygen. The roots of certain trees which grow in the water or in saturated soil in various parts of the world[2] develop pneumatophores—projections which rise vertically above the surface. These processes, strikingly different from most roots in their negative geotropism, are believed to perform the function of supplying air to the roots, swamp soils being notoriously deficient in oxygen, and with their light, spongy cortex they seem well adapted to the purpose.

In North America the "knees" of the bald cypress (*Taxodium distichum*) are a well-known example of this habit (Pl. LXXIII). They are most conspicuously developed when the tree is growing in a water-covered soil. In the great morasses of the Lower Mississippi and its tributaries these conical outgrowths often rise to a height of 2 meters (about 6 feet) from the roots on which they originate. In Virginia, however, they are never so tall. Shaler[3] believes that the largest cypress knees in the Dismal Swamp do not exceed 9 decimeters (3 feet) in height, measured from their base on the root proper. My own observations indicated that the knees rise usually about 3 decimeters (1 foot), but sometimes 6 or 8 decimeters (2 to 2½ feet) above the surface of soil or water. An interesting peculiarity of the knees in this region is that they appear as if still living long after the destruction of the tree which produced them, another evidence of the preservative effect of the swamp water.

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[1] See p. 390.

[2] Compare Goebel, Ueber einige Eigentümlichkeiten der südasiatischen Strand-vegetation; Pflanzenbiolog. Schilderungen, Theil 1. The occurrence on the roots of pneumatophores is there noted in certain palms, in the sugar cane, in a species of Jussiaea, and especially in two trees of the mangrove formation, *Sonneratia acida*, and an Avicennia (pp. 139 to 144). In his paper on "Wasserpflanzen," Biolog. Schild. Theil 2, pp. 256 to 259, Goebel notes the presence of pneumatophores in the case of some semiaquatic plants.

[3] Ann. Rep. U. S. Geol. Surv., vol. 10, p. 323.

Arching of the larger roots which lie on or near the surface of the soil is a peculiarity of both Taxodium and *Nyssa biflora* (Pls. LXIX, LXXIII). In case of the former it is the initial step to knee forming, as these projections seem always to form the summits of root arches. One cypress root which was examined had 1 meter (nearly 4 feet) of its length raised above the surface of the ground, to a maximum height of 25 centimeters (8 inches). The arches are usually, however, shorter and rather higher. In *Nyssa biflora* such a striking development of arched roots as that figured by Shaler[1] was not observed. In both species the roots above ground are more or less compressed laterally. It is possible that the elevation of such arched portions of the root above the surface of the substratum is, like the development of pneumatophores, useful to the plant by aerating the underground parts of the root system, but exact knowledge on this point is wanting.

Distension or tumidity of the basal part of the trunk, already mentioned, is a peculiarity common to most of the larger swamp trees, although more conspicuous in Taxodium and the two species of Nyssa (*biflora* and *aquatica*) than in other species. Shaler, who discusses this question at some length in the paper just quoted, is inclined to regard the swollen base as physiologically homologous with the pneumatophores and arched roots, i. e., as an aerating structure. It seems more likely, however, that the principal object is to secure to the tree a firm foundation in the watery, often unstable soil. The fact that most large forest trees, although growing in soils not deficient in oxygen, are more or less enlarged at base, argues for the explanation of this phenomenon on mechanical principles.

"Juniper" (*Chamaecyparis thyoides*), is, from an ecological point of view, chiefly remarkable in that, while always a hygrophile species, often growing in standing water, it exhibits none of the just described structures for facilitating respiration in the subterranean parts. It possesses neither knees nor projecting, arched roots, and the trunk is either not swollen at base, or not as much so as in most ordinary forest trees.

OTHER ECOLOGICAL CHARACTERS.

The preponderance of woody over herbaceous vegetation, characteristic of most parts of the Non-Hygrophile forest, is even more strongly accentuated in the wooded swamps. In the most typical areas, e. g., the Black Gum swamp near Lake Drummond, almost all the embryophytic plants have their stems more or less lignified. Even the char-

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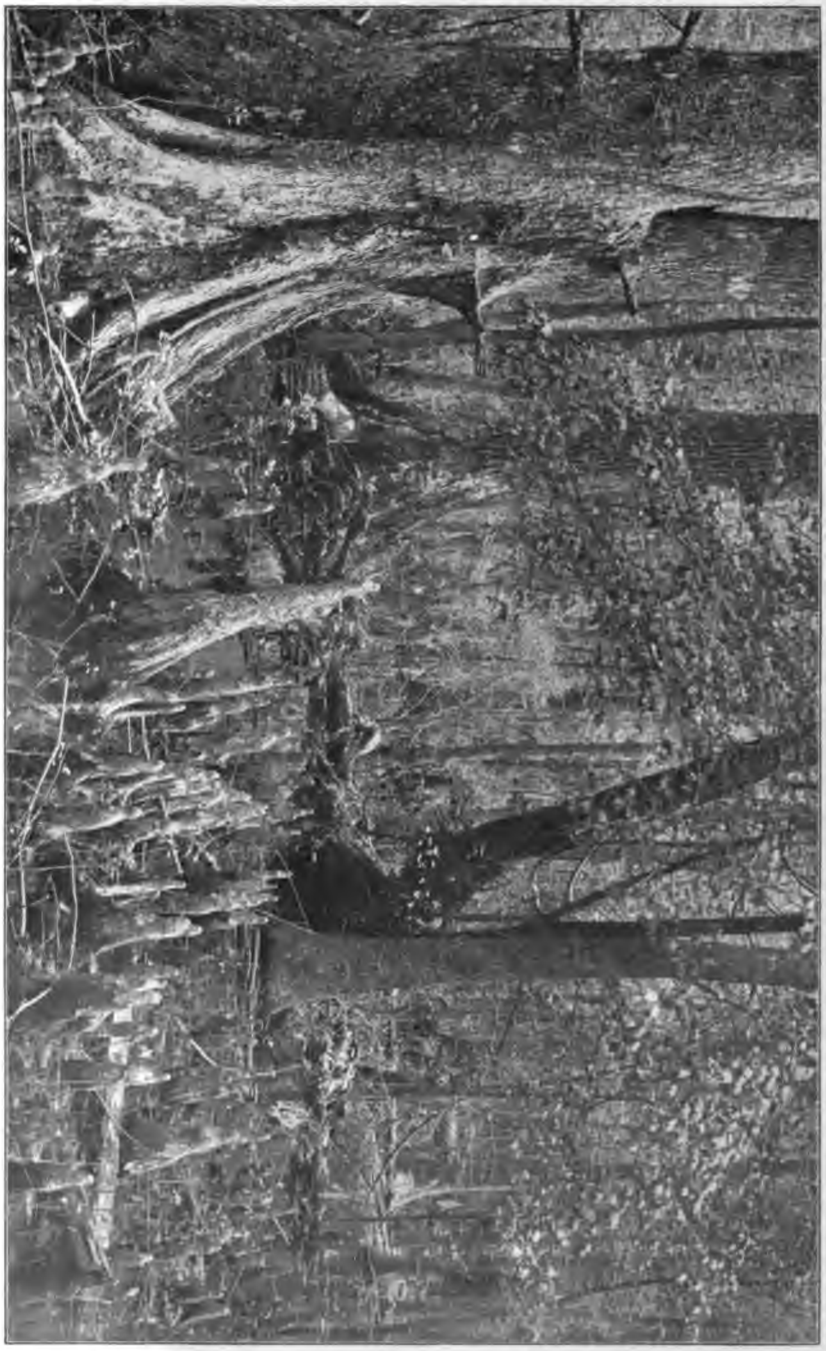
[1] Loc. cit., p. 324, fig. 33.



Cypress Knees and Black Gums (Nyssa biflora) with Swollen Bases.

acteristic grass of the swamp, *Arundinaria macrosperma*, is a woody plant. In the more open parts of the swamp herbaceous forms predominate: in the aquatic vegetation, in areas occupied by the Woodwardia-Sphagnum Association, in the extensive deforested tracts on the periphery of the Dismal, which are chiefly occupied by the Scirpus-Erianthus Association, and in the very limited areas of Low Marsh bordering Lake Drummond.

Among herbaceous phanerogams in the depths of this Hygrophile forest annuals are almost, if not entirely, wanting. Few, if any, of the species complete their development in one growing season. Of life forms, the caespitose form is absent, and likewise the rosette form, so common in the pine barrens. The following are common modes of growth in the wooded swamps:[1]

1. Stems creeping above ground and rooting at the nodes: In *Juncus repens*, *Hydrocotyle umbellata*, *Mitchella repens*, and the most abundant herbaceous grasses, *Panicum gibbum*, *Panicularia brachyphylla*, *P. pallida*.
2. Subterranean rootstocks: Saururus, Rhexia, Lycopus, many grasses, sedges, ferns, etc. In fact, this modification of the lower portion of the stem occurs in a large majority of the herbaceous species.
3. Stolons: *Lycopus rubellus*, *Rhexia mariana*, *R. virginica*, *Scutellaria lateriflora*, *Triadenum virginicum*, etc. Here are to be classed the leafy offsets or extravaginal innovations of many of the grasses and sedges.

Comparatively rare are—

4. Bulbs: present in *Lilium superbum;* and corms, in two orchids, *Tipularia unifolia* and *Limodorum tuberosum*.
5. Tubers: On the rootstocks of *Apios apios* (*tuberosa*) and of species of *Smilax*.

The epiphytic form, which is only sparingly represented here, has already been sufficiently discussed. The only purely parasitic herbaceous embryophyte observed was *Cuscuta gronovii*. No purely saprophytic flowering plant was detected in the woody swamps, although this life form is probably represented.

An impressive feature of the Great Dismal Swamp, especially of the typical Black Gum forest, is its ecological affinity to the tropical "rain forests" (Regenwälder), an affinity which appears in a much slighter degree in the systematic relationship of the species. A number of factors which contribute to this resemblance can at once be distinguished.

1. The general character of the trees, with their arched roots, swollen bases, and straight stems almost devoid of branches to a great height.

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[1] Some of the species here enumerated belong properly to marsh associations, and will be mentioned in that connection.

2. The scarcity of terrestrial herbaceous vegetation.
3. The abundance of large, high-climbing lianas which open their blossoms in the tree tops.
4. The almost omnipresence of a woody, bamboo-like grass.
5. The occurrence of vascular epiphytes.
6. The presence of a woody, loranthaceous parasite on the trees.
7. The abundance of thick, evergreen, laurel-shaped leaves, with shining upper surface.

Of course the tropical influence is, after all, weak, and one can readily call to mind many characteristics of the Rain Woods that are not represented in this far extra-tropical region. Such are epiphylly (epiphytes on leaves); showy-flowered epiphytes and parasites; cauliflory (flowers produced from the old wood of trees); trees with compound leaves; trees with "plank roots;" certain ombrophobous modifications, such as long-channeled points to the leaves, which carry off rain water, etc. Moreover there are many ecological forms that coincide with large systematic groups of the Tropics, and are wanting in the Dismal Swamp region, e. g., tree ferns, palms, climbing and epiphytic aroids, epiphytic orchids, epiphytic trees and shrubs (Ficus, Clusiaceae).

FRESH-WATER MARSH FORMATIONS.

REED MARSH FORMATION.

Along rivers—Typha-Sagittaria Association.—Above the normal influence of brackish water the larger streams of the region are fringed by a usually narrow belt of marsh vegetation, which, on the one hand, passes gradually into the salt marsh downstream; on the other, into the wooded swamps above. Typical examples are to be seen along the Nansemond, the Northwest, the Pasquotank, and other rivers, usually at or just above the upper limit of navigation. Like the marshes with a saline substratum, this formation is characterized by the preponderance of species with a grass-like habit and by the scarcity or entire absence of woody plants. When these occur, they are usually small cypress trees (*Taxodium distichum*), bushes of alder (*Alnus rugosa*), willow (*Salix nigra*, *S. wardi*), red maple (*Acer rubrum*), *Itea virginica*, *Magnolia virginiana*, *Rosa carolina*, *Clethra alnifolia*, *Cephalanthus occidentalis*, etc., which sometimes support certain lianas—*Smilax laurifolia*, *Berchemia scandens*, *Clematis crispa*. Woody plants are usually absent from the wettest part of the marsh which borders the open channel of the stream, and first appear on higher ground farther back, becoming more and more numerous until the open marsh passes over into the swampy forest.

The outermost growth in water commonly 15 to 30 centimeters (6 to 12 inches) deep is most often dominated by the cat-tail (*Typha latifolia*), which sometimes forms a nearly pure association. A tall Sagittaria (*S. lancifolia*) and the showy pickerel weed (*Pontederia* *cordata*) almost always grow with the Typha. Bulrush (*Scirpus lacustris*), wild rice (*Zizania aquatica*), usually small and 1 meter or so (3 or 4 feet), but sometimes 2½ meters (8 feet) high, *Sium cicutaefolium*, and *Polygonum hydropiperoides* are ordinarily abundant elements in this assemblage. At some points great quantities of *Acorus calamus*, in nearly pure association, occupy that zone of the marsh which immediately borders the open water. In limited areas *Juncus effusus* is predominant in the growth that fringes open water. In others *Dianthera américana* prevails, and is sometimes infested with masses of the golden-yellow stems of *Cuscuta gronovii*.

Farther from the channel, where the ground is a few centimeters higher and the depth of the surface water is less, a greater variety of species occur, many of which are characterized by showy flowers. Indeed, there is no plant association of the region that is more noteworthy in this respect, as the absence or scarcity of woody plants permits a better display of the bright colors than is elsewhere possible. Here, as in the outer belt, monocotyledons of grass-like habit are the dominant form. *Scirpus cyperinus eriophorum* is often abundant. The saw grass (*Cladium effusum*), so characteristic of the great marshes in southern Florida, is sometimes the principal element of the middle belt, especially along the Pasquotank River, near Elizabeth City. It does not grow as large as it does farther south, 1 to 1½ meters (4 or 5 feet) being the common height. *Juncus canadensis*, *J. effusus*, and other rushes are common. Species of Rynchospora (*inexpansa*, *glomerata*), of Eleocharis, and of Carex, notably C. *stricta* (forming strong tussocks), and, usually in rather shady places, *C. gynandra* contribute largely to the plant covering. The handsome lilac-colored blossoms of *Iris caroliniana* are conspicuous in spring, and the brilliant orange-red flowers of *Asclepias lanceolata* (*pauper-cula*) are even more so in midsummer. *Erianthus saccharoides* is usually not abundant in the river marshes, but always attracts the eye when present. The white, button-shaped heads of *Eriocaulon decangulare* and the beautiful, fragrant, rose-pink blossoms of *Sabbatia dodecandra* are often characteristic features of this association. In autumn the yellow rays of *Bidens trichosperma* give a bright color to the whole marsh. *Trisetum palustre* and *Saururus cernuus* prefer the shadier edges of the open marsh. *Cicuta maculata* attains a great size in such situations, one plant having been observed which was 2½ meters (8 feet) high, and 3 centimeters (over an inch) in diameter at base. The suffruticous *Decodon verticillatus*, with numerous clusters of showy purple flowers, is often abundant on the inner edge of the marsh.

Numerous smaller and less showy plants enter into this association—*Centella asiatica*, *Hydroctyle umbellata*, *Proserpinaca pectinata*, etc.

Edges of Hygrophile Forest—Scirpus-Erianthus Association.—Extensive tracts of wet land formerly covered with forest, but now almost destitute of living trees, border the Dismal Swamp, especially on the north and east, while similar smaller areas occur at the edges of the lesser wooded swamps. In the plant covering of such places *Scirpus cyperinus eriophorum* is almost invariably the most important element. This handsome sedge usually grows to a height of 1 to 1½ meters (4 or 5 feet). With it, but in smaller numbers, usually occurs *Erianthus saccharoides*, very showy with its tufts of tall culms terminating in light colored, plume-like panicles (fig. 83). *Typha latifolia* and *Andropogon glomeratus* are likewise often abundant constituents of this association. *Woodwardia virginica* and *Arundinaria tecta* are important in places, but these are species which are as characteristic of the forest formation as of the open marsh. Most of the woody plants that occur in the river marshes are likewise sparsely represented in this association.

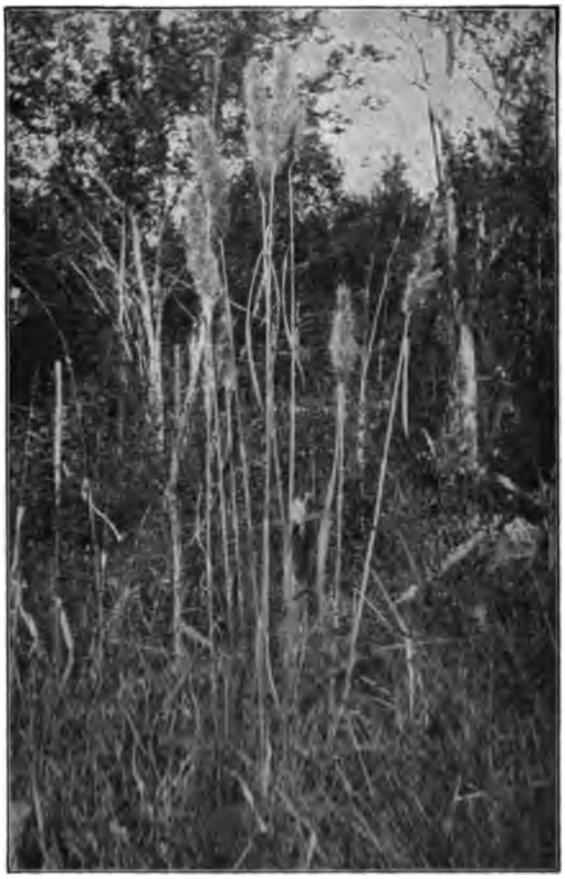

FIG. 83.—*Erianthus saccharoides* on the eastern margin of the Dismal Swamp.

Along ditches and in pools in the heart of the Dismal Swamp the Reed Marsh formation is well represented. *Dulichium arundinaceum* and *Triadenum virginicum* are very abundant in the shallow "turnouts" of the canals, while Saururus is most at home in shady places, where it grows in shallow water or very wet soil, sometimes in pure associations of considerable size. Less important are *Scirpus cyperinus eriophorum*, *S. divaricatus*, *Erianthus saccharoides*, *Eleocharis mutata*, etc.

Topographical, rather than purely ecological considerations make it expedient to distinguish this from the preceding association, although it should be noted that the diversity of forms is much less than in the river marshes and the influence of the adjacent palustrine forest is greater.

LOW MARSH FORMATION.

The term "Low marsh" may be employed as an antithesis to that of "Reed marsh" in order to designate the limited areas of marshy ground or swales which occur here and there in the Forested Plain, especially at waysides, and which are covered chiefly with a low rather than a tall reedy growth. The wet places in the pine barrens, already described under the heading of "Pine Barrens,"[1] could properly be referred to this formation, with which they are ecologically homologous; but, as in other cases, it has seemed best to describe such extremely limited associations in connection with the extensive formations to which they belong topographically. For the same reason the "dune marshes" have been treated in connection with the sand strand, while from the strictly ecological point of view they belong to the "low marshes."

Rynchospora-Eleocharis Association.—The vegetation of the low marshes comprises a great variety of species, predominant among them being numerous sedges. Of these the most abundant are as follows:

Rynchospora cymosa.
Rynchospora inexpansa.
Rynchospora glomerata.
Rynchospora corniculata.
Eleocharis ovata.
Eleocharis tortilis.
Carex verrucosa (characteristic).
Fimbristylis autumnalis.
Fimbristylis laxa.
Lipocarpha maculata.
Fuirena squarrosa.
Cyperus flavescens.
Cyperus flavicomus.
Cyperus pseudovegetus.
Cyperus haspan.

Likewise abundant are various rushes, notably:

Juncus acuminatus.
Juncus acuminatus debilis.
Juncus marginatus.
Juncus canadensis.
Juncus setaceus.
Juncus repens.

Species of Xyris (*X. caroliniana*, *X. ambigua*, etc.) are conspicuous with their bright yellow flowers.

Grasses, mostly with weak, decumbent culms, are often an important element. Examples are:

Panicularia pallida.
Panicum gibbum.
Panicum verrucosum.
Panicum viscidum.

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[1] Above, p. 405.

Among other species that commonly occur in the low marshes are—

Hydrocotyle umbellata.
Hydrocotyle ranunculoides.
Rhexia mariana.
Rhexia virginica.
Ludwigia linearis.
Ludwigia alternifolia.
Triadenum virginicum.
Ptilimnium capillaceum.
Limodorum tuberosum.
Gratiola sphaerocarpa.
Gratiola virginica.
Ilysanthes attenuata.
Ilysanthes gratioloides.
Gerardia purpurea.

Two white-flowered violets (*Viola primulaefolia*, *V. lanceolata*) are likewise characteristic. Most of these plants begin to flower about midsummer, the violets being the principal vernal-flowering species.

Along the Dismal Swamp Canal, in moist, sandy, more or less incoherent soil, which has been heaped up in the process of excavation, this formation is characteristically represented by—

Carex verrucosa.
Juncus canadensis.
Juncus acuminatus debilis.
Juncus repens.
Cyperus erythrorhizos.
Rynchospora glomerata.
Rynchospora axillaris.
Saururus cernuus.
Panicum scabriusculum.
Jussiaea decurrens.
Ludwigia alternifolia.
Gratiola sphaerocarpa.

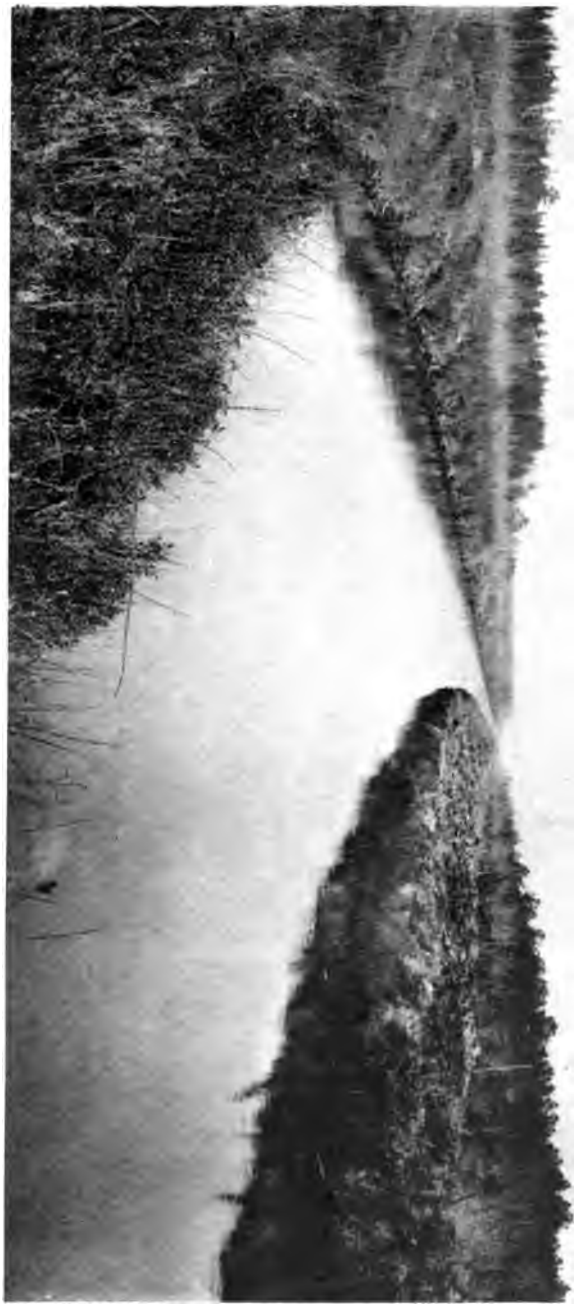
A rank growth of *Cyperus erythrorhizos* 6 decimeters (2 feet) or more high is shown in figure 84. *Funaria hygrometrica* is an abundant moss in the made ground along the canals in early May, but entirely disappears before midsummer. Ferns, notably *Osmunda regalis* and *Woodwardia areolata*, colonize the canal banks from the neighboring swampy forest.

On the margin of Lake Drummond, in the heart of the Dismal Swamp, there is a small area of perhaps a hectare (2½ acres) which is bare when the water level is low. Here occurs an association in which tall plants of the Reed Marsh formation, *Scirpus cyperinus eriophorum* and *Erianthus saccharoides*, mingle with Low Marsh forms. In almost pure white sand at the very edge of the lake *Juncus repens* is abundant, forming a short soft turf. Nearer the bordering woods the soil is a wet muck, composed almost entirely of organic matter, and is somewhat densely covered with a variety of species. *Panicum gibbum*, *Panicularia pallida*, and *Homalocenchrus oryzoides* are conspicuous and ecologically very similar grasses. In midsummer the showy flowers, pale pink to deep rose color, of *Rhexia virginica* and *R. mariana*, are the principal color element. Other species, notably Junci, *Hydrocotyle umbellata*, *Apios apios* (*tuberosa*), and *Decodon verticillatus* help to complete the assemblage.

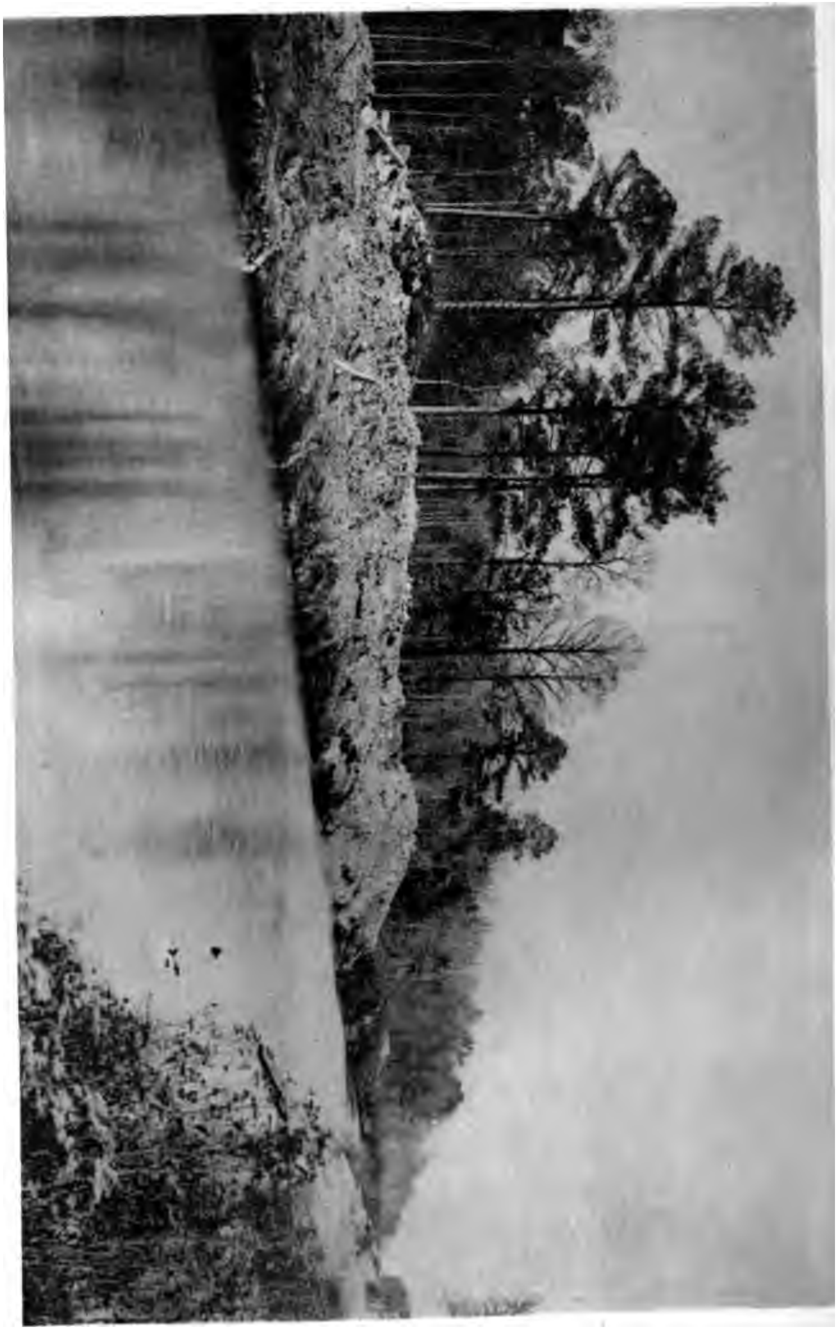
ADAPTATIONS TO ENVIRONMENT IN THE FRESH-WATER MARSH—LIFE FORMS.

The vegetation of the treeless marshes is exposed to certain conditions which, in the palustrine forest, can greatly affect only the large woody plants and the epiphytes. These are—

1. The direct heat and light of the sun, as opposed to diffused light and radiated heat.
2. The unbroken mechanical and physiological action of air currents.



THE DISMAL SWAMP CANAL NEAR SOUTH MILLS, N. C.



FEEDER CONNECTING THE DISMAL SWAMP CANAL WITH LAKE DRUMMOND.

Other important life factors are—

3. Abundant precipitation and atmospheric humidity, as throughout the region.

4. A soil containing abundant moisture, and abundant nitrogenous matter, but relatively cold, poor in oxygen, and probably more or less acid.

This exposure to direct light and the accompanying and resulting heat, as well as to the drying effect of the wind, creates a tendency to excessive transpiration from the foliage. The coldness, and doubtless acidity, of the substratum, moreover, reduces the power of the roots to absorb water, although so abundant in the soil. Therefore it is not surprising that the vegetation of the fresh-water marshes, like that of the salt marshes, exhibits in a certain degree those peculiarities which are often termed "xerophytic." Indeed, there is but one important point of difference between the environment of the fresh-water marsh vegetation and that of the salt marsh, the absence in the former of any considerable amount of sodium chloride in the soil and

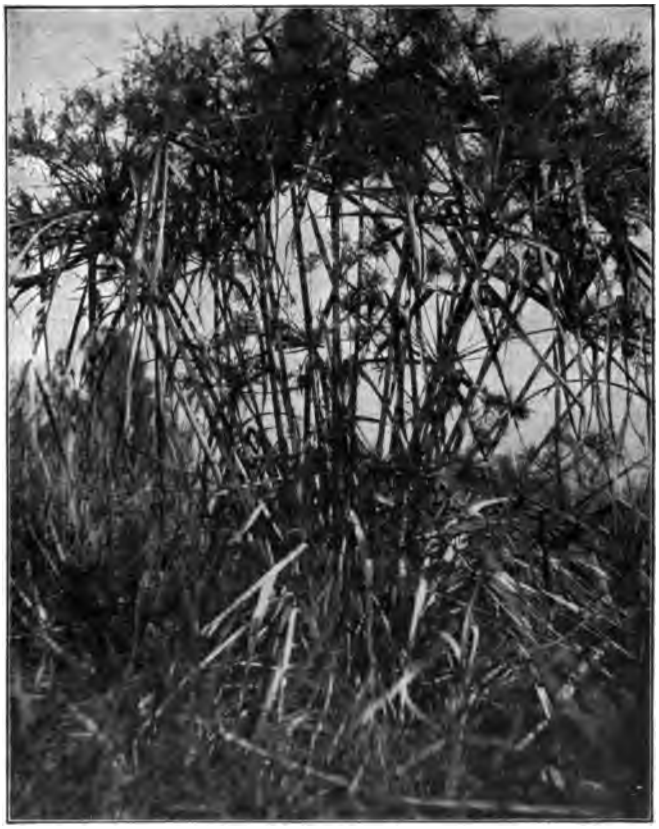


FIG. 84.—*Cyperus erythrorhizos* along the Dismal Swamp Canal.

water. But as that is one of the most effective agents in the development of adaptations against excessive transpiration in salt-marsh plants, the xerophytic quality is naturally much less marked in the vegetation of fresh-water marshes.

In the Fresh-Water Marsh formation it is principally the reed-like monocotyledons which exhibit adaptations that can be regarded as protective against excessive transpiration and too intense light. The position of the exposed leaf surface is chiefly concerned. The leaves are often isolateral; they are usually orthotropic (vertical) or nearly so; the margins are sometimes involute (Cladium, Rynchospora, and numerous other sedges and many of the grasses), or the leaf is even terete (species of Juncus); and in several cases, e. g., Iris, Acorus, Xyris, Typha, the leaves are equitant, with edges opposed to the greatest number of incident rays. The cuticle is often considerably thickened. Hairy or waxy coverings, on the other hand, are either wanting or so little developed as to be of slight protective value. Neither the possession of leathery leaves with shining upper surface nor of water-storage tissue (succulency) are characteristic of this formation.

The remainder of the Fresh-Water Marsh vegetation exhibits little or no xerophytic structure. It is, indeed, for the most part markedly hygrophile. The tall, reed-like plants afford the smaller forms considerable shelter from sun and wind, so that the majority of them require no other protection against excessive transpiration. A result of that exposure to the direct mechanical action of the wind to which the vegetation of the larger marshes, unsheltered by tall woody plants, is subjected is the development of much strengthening tissue (stereome), noticeable especially in the stems and leaves of many of the sedges, grasses, and rushes.

The marsh vegetation is established upon a watery, incoherent soil which would afford but a precarious footing to the plants were not most of them especially fitted to hold themselves in place by their strong, creeping, in many cases branching, rootstocks. This is conspicuous, as in the salt marsh formation, in the case of tall, heavy plants like *Typha latifolia*, *Erianthus saccharoides*, *Scirpus cyperinus*, *S. lacustris*, *Cladium effusum*, etc. The richness of the substratum in organic matter permits a dense, luxuriant plant covering, and thus the danger to the individual plant of being uprooted is reduced to a minimum. Some of the lower growing plants, being less liable to this danger, have thick, comparatively short rootstocks, which are better adapted to the storage of reserve food than to soil binding. Such are *Acorus calamus*, *Peltandra virginica*, *Pontederia cordata*, *Iris caroliniana*. *Cicuta maculata* has a cluster of fleshy, dahlia-like roots.

Water contains of course a smaller percentage of free oxygen than does the atmosphere. Consequently a soil rich in water is relatively poor in free oxygen, and all the more so if the soil is acid.

Now, oxygen, as we know, is necessary to the roots, as to all other organs of the plant, furnishing energy for the carrying on of their vital processes. We have seen that the knees of the bald cypress possibly supply the roots of that tree with oxygen which they obtain from the air and transmit through their open, spongy cortex. A similar function is probably performed in various herbaceous marsh plants by the soft, open tissue which often forms a thickening near the base of the stem (or rather, just above the surface of the water or the watery soil) to which Schenck[1] has given the name *aërenchyma.* This spongy, aerating tissue, usually bright white in color, is developed in the cortex and soon ruptures the epidermis, usually first breaking through longitudinal fissures. Although analogous to cork in its point of origin true aerenchyma consists of delicate parenchyma with thin, nonsuberized walls, and contains, when fully developed, numerous large intercellular spaces. It is particularly noticeable in this region in species of the three related orders, Lythraceae (*Decodon verticillatus*),[2] Melastomaceae (*Rhexia virginica*), and Onagraceae (*Ludwigia linearis*). South of the Dismal Swamp region, in the latitude of Cape Hatteras, occur other species which develop aerenchyma, i. e., *Rhexia glabella*, *Ludwigia pilosa*, and *L. glandulosa.* In *Ludwigia linearis*, however, most of the thickening tissue, at least toward the end of the growing season, and in *L. pilosa* all of it above the very base of the stem, is suberized, and therefore not true aerenchyma.

AQUATIC VEGETATION.

The true water plants of the region were not studied with the same care as was bestowed upon other formations, because with this part of the plant covering the problem which was kept chiefly in view during the progress of the survey does not especially concern itself, and because an exhaustive ecological investigation of the aquatic flora of a region demands much more time than could be devoted to it in this case. Consequently only a superficial description of this interesting formation is possible here, and the lower forms, algae, etc., are not treated.

This, unlike most of the other formations, presents no clearly defined associations corresponding to topographical conditions. On the contrary, the distribution of aquatic plants seems to be largely determined by the accidents of dissemination, so that in this pond one species or life form, in that another, may happen to predominate. Therefore it has seemed most expedient to present a general view of the aquatic vegetation of the entire region without attempting to subdivide the formation, and to follow this with a classification of the ecological forms. These, like the systematic forms (as to genera and families), are, without exception, such as are widely distributed over the face of the globe.

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[1] Über das Aërenchym, ein dem Kork homologes Gewebe bei Sumpfpflanzen; Jahrb. für wissenschaft. Botanik, vol. 20, pp. 526 to 574, *t. 23 to 28* (1889). Also Goebel, Wasserpflanzen: Biolog. Schild. Theil 2, pp. 259 to 266 (1891).

[2] See J. Schrenk, Bull. Torr. Bot. Club, vol. 16, pp. 315 to 323, pls. 95 to 97 (1889).

COMPOSITION AND PHYSIOGNOMY.

The greater part of the aquatic vegetation occupies bayous, ponds, and ditches, where the current is very feeble or none is perceptible. *Philotria canadensis* was the only truly aquatic embryophyte which was observed to grow in the channel of the larger streams.

Myriophyllum heterophyllum and *Castalia odorata* are two of the most abundant and characteristic water plants of the region, and are often associated, especially in the numerous shallow pools which occur in the open marsh land that borders the Dismal Swamp on the north. The water lily is especially common, covering the surface of ponds with its shining leaves and handsome white flowers. Both species have strong rhizomes that creep in the mud at the bottom. But, while the stout brittle stems of the Myriophyllum, often over 1 meter (40 inches) long, rise above the surface of the water, Castalia usually sends up its petioles and pedicels only so far that the fully developed leaves and flowers float upon the surface. In *Myriophyllum heterophyllum* the upper part of the stem, often to a length of 2 decimeters (over 6 inches), is emersed and bears simple, entire, or merely serrate leaves, which are sharply differentiated from the finely divided submersed ones. Both Castalia and Myriophyllum prefer water that is exposed, at least for some hours of the day, to direct sunlight.

Nymphaea advena, which is sometimes terrestrial and then enters the Reed Marsh formation, is often aquatic, with the habit of Castalia. The handsome yellow lotus (*Nelumbo lutea*) was observed only near Edenton, N. C., where it covered densely a shallow bayou opening into Albemarle Sound. The great orbicular, peltate leaves either float upon the surface of the water or are lifted considerably above it upon elongated petioles. The pale yellow flowers are likewise lifted above the surface. Growing among the petioles and pedicels of Nelumbo were great quantities of free-swimming *Spirodela polyrhiza*, which in other quiet waters of the region sometimes grows in nearly pure association, spreading a sheet of green over the surface.

Almost as important as Castalia and Myriophyllum are species of Utricularia, notably *U. purpurea* and *U. inflata*, which are also plants that grow best where their floating or emersed portion is exposed to the sun's rays. *U. purpurea* is most abundant in ditches in the open part of the Dismal Swamp, where it associates with *Castalia odorata* or, in the recesses of the morass, with *Sphagnum cuspidatum plumosum* forma *serrata*, and *S. kearneyi*. It often grows in such great quantity as to obstruct navigation in the smaller canals by pole, paddle, or wheel. The masses of stems and leaves, with innumerable swim bladders, float just beneath the surface of the water, unattached to the bottom, and send up into the air peduncles bearing numerous small purple flowers. *U. inflata*, on the other hand, inhabits open ponds outside the palustrine forest, where it is often accompanied by *Callitriche heterophylla*. The inflated petioles of its uppermost whorl of leaves form a small buoy, which floats upon the surface and enables the summit of the stem, with its raceme of bright yellow flowers, to develop outside the water. The submersed leaves are provided with numerous bladders.

The hepatic *Riccia fluitans* is a common plant of the region, often growing terrestrially, even in moist corn fields, but also occurring in an aquatic form, which floats just beneath the surface of ponds.

Isnardia (*Ludwigia*) *palustris* and *Juncus repens* are likewise often terrestrial marsh plants, but sometimes grow in shallow water, where only their uppermost leaves reach the surface. The difference between the terrestrial and aquatic forms of *Juncus repens* is striking.[1] The former has short creeping stems, with short internodes and leaves, often makes a veritable sod, as on the margin of Lake Drummond, and flowers profusely. The water form develops greatly elongated internodes and longer leaves, and apparently does not produce flowers. It sometimes grows in water 3 decimeters (1 foot) deep.

The species of Sphagnum, *S. cuspidatum plumosum* forma *serrata* and *S. kearneyi*, already mentioned as associating with *Utricularia purpurea* in the waters of the ditches in the Dismal Swamp, are there the most abundant of the aquatic plants. Their stems, usually 3 to 6 decimeters (1 to 2 feet) long, often become detached, and seem to grow equally well when floating freely. Either they are wholly submersed or the uppermost portion is emersed. The foliage is very pale, especially upon the submersed portion.

Inhabiting the cold water of ditches in the heart of the Dismal Swamp, where the amount of direct sunlight which reaches the surface of the water is small or none, are *Potamogeton lonchites*, with stems rooting in the mud at the bottom and with its firm, rather large, uppermost leaves floating, and *Sparganium androcladum*, likewise rooted in the substratum, while the upper part of the stem, bearing the uppermost leaves and the inflorescence, rises into the air.

ADAPTATIONS TO ENVIRONMENT.

The characteristic aquatic plants of the Dismal Swamp region may be ecologically classified as follows:[2]

1. Submersed:

(*a*) Freely floating (near the surface): *Utricularia* spp. (flowering peduncles emersed): *Riccia fluitans*.

(*b*) Attached to the bottom: *Philotria canadensis* (always submersed); *Sphag-*

See Holm, Bull. Torr. Bot. Club, vol. 26, p. 359 (1899).

Following roughly the classification used by Schenck, Biologie der Wassergewachse.

num kearneyi and *S. cuspidatum plumosum* forma *serrata* (often submersed): *Callitriche heterophylla*, *Juncus repens*, and *Isnardia palustris* (sometimes submersed).

2. Floating upon the surface.

(*a*) Freely: *Spirodela polyrhiza*.

(*b*) Attached to the bottom, uppermost leaves floating:

Flowers floating—*Castalia odorata*, *Nymphaea advena* (usually).

Flowers usually emersed—*Nelumbo lutea*, *Potamogeton lonchites*.

Flowers submersed—*Callitriche heterophylla* (usually).

3. Rising above the surface, attached to the bottom: *Sparganium androcladum* and *Myriophyllum heterophyllum* (the uppermost flower-bearing portion of the stem emersed).

The general characteristics of aquatic plants are much the same the world over, and have been so often described that a detailed account of them here would be superfluous.

The root system is usually comparatively little developed, since water plants absorb most of their fluid nutriment directly through the foliage. In the freely swimming forms the roots reach their minimum development, being entirely aborted in some cases, while in larger plants that are attached to the bottom there is a greater production of mostly simple roots, which are perhaps chiefly used as holdfasts.

The stems in the latter group usually creep at some distance over the bottom as rhizomes, sending down roots into the soil before rising toward the surface. That portion of the stem which ascends through the water is most frequently slender and branching. The rootstock is sometimes thickened and serves for the storage of reserve food, especially in the Nymphaeaceae.

The submersed leaves are usually either elongated, narrow, and flexuous (*Philotria canadensis*, *Juncus repens*, *Sparganium androcladum*), or finely divided with filiform segments (*Myriophyllum heterophyllum*, *Utricularia* spp.); and, in Utricularia, provided with insectivorous bladders. They are always thin and delicate, wilting rapidly when exposed to the air. The floating leaves are more often broad (*Potamogeton lonchites*, *Nymphaea advena*), often orbicular, or nearly so, and peltate (Nelumbo, Castalia), and with an ombrophobous (water-shedding) upper surface. Peculiarly specialized are the floating leaves of *Utricularia inflata*, mentioned above.

In anatomical structure water plants are chiefly remarkable for the feeble development of certain elements which are strongly developed in most land plants. In the stem the mestome bundles are small, and are grouped together in a central cylinder with the vessels few and but slightly or not at all lignified. Large lacunes, which probably serve as an aerating apparatus, are present. Mechanical strengthening tissue is in most cases wanting.

Submersed leaves usually have few or no stomata, chlorophyll tissue of the spongy type (no palisade), epidermis without hairs, its cell walls not thickened, the radial walls usually undulate and the cells often containing chlorophyll. In short, there is a total lack of provision against excessive transpiration, and this explains the rapidity with which submerged aquatics wilt when removed from the water. The floating leaves are better protected, possessing stomata (on the upper surface only); a thicker-walled epidermis; often true palisade; and sometimes a dense covering of papillae (e. g., Nelumbo), which causes water to roll off the surface without wetting it. In aquatics of this class a transpiration current is maintained from the roots to the leaf surfaces. Large floating leaves are, moreover, provided with more or less mechanical strengthening tissue and with large intercellular spaces near the lower surface which serve as swim-bladders, cooperating with the water-shedding papillae in keeping the leaf afloat upon the surface and the layer of palisade always horizontal and opposed to the light rays.

The flowers of embryophytic water plants in most cases either are emersed or float upon the surface.

PHYTOGEOGRAPHICAL AFFINITIES OF THE FLORA.

The factor in the physical environment of plants and animals which exerts the largest control over their geographical distribution is temperature. It is the sum total of effective temperatures (above 6° C.) received during the period of greatest vital activity, the "growing season," that seems to determine the polar or the upward limit beyond which a given organism can not successfully maintain itself against the stress of its physical or biological environment. Hence it is the sum of effective temperatures which fixes the limits, polar in point of latitude, upward in point of altitude, of the great life zones. These zones in North America, as now often recognized,[1] are as follows:

1. Boreal Region.
    (*a*) Arctic-Alpine zone.
    (*b*) Hudsonian zone.
    (*c*) Canadian zone.
2. Austral Region.
    (*d*) Transition zone.
    (*e*) Upper Austral zone { Carolinian area.
        Upper Sonoran area.
    (*f*) Lower Austral zone { Austroriparian area.
        Lower Sonoran area.
3. Tropical Region.

Another factor which in great measure controls the distribution of life on the surface of the globe is water. The quantity of atmospheric humidity and of rainfall is next in importance to that of heat in determining the distribution of plants, and, less directly, of animals. We have, therefore, a division of the Lower Austral life zone into two areas—an eastern or humid, the Austroriparian area; and a western or dry, the Lower Sonoran area. The actual difference in quantity of rainfall which fixes the dividing line between these two areas has not yet been ascertained. They are even more strikingly different ecologically than in their systematic forms, the humid area being heavily forested, while the dry Lower Sonoran area is destitute of forest in the strict sense of the term.

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[1] Merriam, C. H., Yearbook U. S. Dept. Agr. for 1894, pp. 203 to 214 (1895); and Bull. Div. Biolog. Surv., U. S. Dept. Agr., No. 10, pp. 18 to 53 (1898).

POSITION IN THE LIFE ZONES OF NORTH AMERICA.

The southeastern corner of Virginia, including the Great Dismal Swamp, constitutes the northeastern termination of the Austroriparian Area. Here this area covers but a limited tract which does not greatly exceed the bounds of the Dismal Swamp region. It is the low elevation of this strip of sandy coastal plain and its neighborhood to the ocean that permits the presence of Austroriparian flora, while not far westward, with a comparatively only slight increase of altitude, the Austroriparian element becomes subordinated to the Carolinian (Upper Austral), which prevails throughout the hilly middle country or Piedmont region of Virginia, the Carolinas, and Georgia, as well as in the greater part of Maryland, Delaware, and New Jersey. This transition from the Lower to the Upper Austral zone is probably induced as much by increasing distance from the sea, with its tempering influence upon the climate, as by the relatively insignificant increase in the elevation of the land.

Farther southward the width of the Austorriparian belt constantly increases. In North Carolina it covers nearly one-third the total area of the State, while fully half of South Carolina and Georgia and the whole of Florida, excepting the extreme southern (tropical) portion, belong to this zone.[1]

AUSTRORIPARIAN PLANTS REACHING THEIR NORTHERN LIMIT IN THE DISMAL SWAMP REGION.

Not a few species of plants which belong properly to the Lower Austral zone range, in gradually decreasing number of forms and individuals, north of the mouth of Chesapeake Bay. Nevertheless, as a whole, or, better speaking, as the predominant floral element, the Austroriparian flora finds there its northeastern limit. Conversely, many of the species that inhabit the Dismal Swamp are most abundant in and characteristic of the Upper Austral zone (Carolinian area), and some even belong to the Transition zone. But the most conspicuous and abundant species, such as contribute largely to the physiognomy of the vegetation, are properly Austroriparian plants. Among these "character plants" are a considerable number which do not extend north of the Dismal Swamp region, namely:

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[1] The limits of this area are defined by Dr. Merriam (Bull. Div. Biol. Surv., U. S. Dept. Agr. No. 10, p. 45) as follows: "The *Austroriparian* area occupies the greater part of the South Atlantic and Gulf States. Beginning near the mouth of Chesapeake Bay, it crosses more than half of Virginia, North and South Carolina, Georgia, Florida, Alabama, the whole of Mississippi and Louisiana, eastern Texas, nearly all of Indian Territory, more than half of Arkansas, southern Missouri, southern Illinois, the extreme southwestern corner of Indiana, and the bottom lands of western Kentucky and Tennessee." It does not seem proper that so much of Virginia and North Carolina should be included in the Lower Austral zone. Certainly the flora of all but the most eastern portion of Virginia is predominantly Carolinian rather than Austroriparian.

Pinus palustris.
**Erianthus saccharoides.*
**Panicum gibbum.*[1]
**Uniola paniculata.*
Arundinaria macrosperma.
**Cyperus haspan.*
**Fimbristylis spadicea.*
Cladium effusum.
Carex verrucosa.
**Tillandsia usneoides.*
Atamosco (Zephyranthes) atamasco.
Quercus laurifolia.
**Quercus virginiana.*
Clematis crispa.
Persea borbonia.
Persea pubescens.
**Decumaria barbara.*[1]
Zanthoxylum clava-herculis.
Jatropha stimulosa.
Berchemia scandens.
Cornus stricta.
Nyssa aquatica.
Nyssa biflora.
Leucothoë axillaris.
**Pieris nitida.*
Styrax grandifolia.
**Fraxinus caroliniana.*
Gelsemium sempervirens.
Callicarpa americana.[1]
**Physalis viscosa.*
Bignonia crucigera.[1]
**Eupatorium capillifolium.*
**Borrichia frutescens.*

Those species whose names are preceded by an asterisk (*) are not confined to the Lower Austral zone, but extend southward into the tropical region. A complete list of the species which are known to reach their northern limit in the Dismal Swamp region is given in the table of northern limits of Austroriparian species, which will be found at the end of this chapter.

PLANTS REACHING THEIR SOUTHERN LIMIT IN THE DISMAL SWAMP REGION.

Besides the Lower Austral element which dominates the flora of this region and the large number of Upper Austral species, there are a number of plants which apparently here reach their southern limit, at least in the Coastal plain. These belong to three categories: (1) Strand plants hardly to be reckoned to any of the life zones; (2) mostly palustrine species, chiefly of boreal origin, to which the cold, wet soil of the swamps offers a congenial environment; and (3) non-palustrine species, which are either of the Transition zone or of both that and the Upper Austral. A prefixed (*) indicates that the species reaches its actual austral limit in point of latitude, irrespective of altitude, in the Dismal Swamp region.

1. STRAND PLANTS.

**Ammophila arenaria.*[2]
**Festuca rubra.*[3]
**Lechea maritima.*[4]
**Ammodenia peploides.*
**Hudsonia tomentosa.*

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[1] Occurs sparingly in mountain valleys in eastern Tennessee.

[2] Ranges several miles south of Virginia Beach and perhaps into North Carolina.

[3] The var. *glaucescens* Hack. occurs in central Tennessee.

[4] Accredited by Watson to Georgia, but this requires confirmation.

2. PALUSTRINE SPECIES.

Dryopteris (Aspidium) spinulosa dilatata.
Panicularia (Glyceria) brachyphylla.
**Panicularia obtusa.*
Panicularia pallida.
**Carex canescens.*
Gaultheria procumbens.
**Utricularia clandestina.*

3. NONPALUSTRINE SPECIES.

Carex costellata.
Juncoides (Luzula) pilosum.
Cypripedium acaule.
Salix fluviatilis (longifolia).
Potentilla pumila.
Agrimonia striata.
Valerianella chenopodifolia.

NORTHERN LIMITS OF AUSTRORIPARIAN PLANTS REACHING THE DISMAL SWAMP REGION.

The following tables give the northern limit of most of the characteristic species belonging to the Coastal plain or Austroriparian area, which extend northward along or near the coast as far as the southern border of North Carolina or farther. In some cases there is room for doubt as to whether the species is really of Austroriparian rather than of Carolinian origin. But the great majority of the species tabulated unquestionably reach their greatest development and widest distribution in the former zone.

A number of signs are used in order to denote the further distribution of the given species. Thus an asterisk (*) indicates that the species so designated also extends into the Tropical Zone, or at least into subtropical parts of Mexico or the West Indies. A dagger (†) is appended to the names of species which range northward in the Mississippi Valley to latitude 36° or farther. A double dagger (‡) denotes a strand plant. Species of that formation usually have a wider range than is embraced within the limits of a single life zone. Species indicated in the columns of the table by a cross (×) are definitely known to extend northward to the latitude given. In almost every case such record of northward range is based upon the examination of reasonably authentic specimens. A query (?) in one of the columns, opposite the name, indicates that the species is reported to range thus far northward, but is not certainly known to do so. A number of these Austroriparian plants also occur in more or less limited areas in the midst of the Carolinian, or even of the Alleghanian (Transition) zones, chiefly in the Appalachian area, or farther west. Such stations are to be regarded as outposts of the main Austroriparian flora, for which local conditions of climate or soil exposure (or of both) are responsible.[1]

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[1] See Kearney, The Lower Austral element in the flora of the southern Appalachian region, Science, n. ser., vol. 12, p. 830 (1900).

Northern limit of species.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Lycopodium alopecuroides L								×			
Lycopodium carolinianum L								×			
Pinus palustris Mill					×						
Pinus serotina Mx			×								
Pinus taeda L							×				
Taxodium distichum L							×				
Chamaecyparis thyoides (L.) B. S. P											×
Triglochin striata (L.) Ruiz & Pav.*							×				
Sagittaria lancifolia L.*							×				
Sagittaria subulata (L.) Buchenau									×		
Sagittaria teres S. Wats											×
Erianthus compactus Nash								×			
Erianthus contortus Ell											
Erianthus saccharoides Mx					×						
Manisuris rugosa (Nutt.) Kuntze							×				
Andropogon argyraeus Schult.†							×				
Andropogon glomeratus (Walt.) B. S. P									×		
Andropogon tetrastachyus Ell					×						
Paspalum compressum (Sw.) Nees*											
Paspalum floridanum Mx							×				
Paspalum membranaceum Walt							×				
Paspalum paspaloides (Mx.) Scribner							×				
Paspalum praecox Walt			×								
Paspalum purpurascens Ell					×						
Amphicarpon amphicarpon (Pursh) Nash								×			
Anthaenantia villosa Beauv	×										
Syntherisma serotinum Walt											
Panicum amarum Ell					×						
Panicum amarum minus Vasey & Scribn										×	
Panicum angustifolium Ell											
Panicum ciliatum Ell					×						
Panicum columbianum Scribner											×
Panicum digitarioides Carpenter							×				
Panicum gibbum Ell					×						
Panicum hians Ell.†	×										
Panicum lanuginosum Ell								×			
Panicum longifolium Torr										×	
Panicum nashianum Scribner					×						
Panicum neuranthum Griseb					×						
Panicum pauciflorum Ell					×						
Panicum scabriusculum Ell					×						
Panicum sphagnicola Nash								×			
Panicum verrucosum Muhl											×
Panicum viscidum Ell.†								×			
Oplismenus setarius (Lam.) Nash			×								
Chaetochloa perennis (Curtis) Bicknell											
Chaetochloa imberbis perennis (Hall) Scribn. & Merrill											
Cenchrus incertus M. A. Curtis											
Cenchrus tribuloides macrocephalus Doell								×			
Homalocenchrus hexandrus (Roem. & Schult.) Britton	×										
Hydrochloa fluitans (Mx.) Nash											
Zizaniopsis miliacea (Mx.) Doell & Aschers											
Phalaris caroliniana Walt											
Aristida lanata Poir							×				
Aristida stricta Mx			×								
Aristida virgata Trin	×										
Muhlenbergia filipes M. A. Curtis			×								
Sporobolus junceus (Mx.) Kunth	×										
Sporobolus virginicus (L.) Kunth*											
Agrostis altissima (Walt.) Tuckerm								×			
Agrostis elliottiana Schult.†											
Danthonia sericea Nutt											×
Campulosus aromaticus (Walt.) Scribner			×								
Chloris petraea Sw.*			×								
Gymnopogon ambiguus (Mx.) B. S. P								×			
Gymnopogon brevifolius Trin								×			
Triplasis americana Beauv	×										
Eragrostis hirsuta (Mx.) Nash					×						
Eragrostis nitida (Ell.) Chapm			×								
Eragrostis refracta (Muhl.) Scribner							×				
Uniola laxa (L.) B. S. P									×		
Uniola longifolia Scribner					×						

Northern limit of species—**Continued.**

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Uniola paniculata L.*‡					×						
Arundinaria macrosperma Mx					×						
Arundinaria tecta (Walt.) Muhl							×				
Cyperus compressus L.*+							×				
Cyperus cylindricus (Ell.) Britton									×		
Cyperus echinatus (Ell.) Wood	×										
Cyperus flavicomus Mx					×						
Cyperus grayi Torr											×
Cyperus haspan L.*					×						
Cyperus microdontus Torr					×						
Cyperus pseudovegetus Steud.+							×				
Cyperus stenolepis Torr	×										
Cyperus tetragonus Ell	×										
Eleocharis albida Torr							×				
Eleocharis capitata (L.) R. Br.*+							×				
Eleocharis melanocarpa Torr											×
Eleocharis microcarpa Torr.*								×			
Eleocharis ochreata (Nees) Steud.*					×						
Eleocharis prolifera Torr					×						
Eleocharis tortilis (Link) Schult							×				
Eleocharis tricostata Torr									×		
Eleocharis tuberculosa (Mx.) Roem & Schult											×
Dichromena colorata (L.) Hitchc.*								×			
Dichromena latifolia Baldw			×								
Psilocarya nitens (Vahl) Wood									×		
Stenophyllus stenophyllus (Ell.) Britton	×										
Stenophyllus ciliatifolius (Ell.) Mohr	×										
Fimbristylis castanea (Mx.) Vahl*+									×		
Fimbristylis spadicea (L.) Vahl+					×						
Fimbristylis vahlii (Lam.) Link+	×										
Scirpus cylindricus (Torr.) Wood							×				
Scirpus divaricatus Ell.+					×						
Fuirena squarrosa Mx											×
Fuirena squarrosa hispida (Ell.) Chapm									×		
Hemicarpha micrantha (Vahl) Britton										×	
Lipocarpha maculata (Mx.) Torr					×						
Rynchospora axillaris (Lam.) Britton									×		
Rynchospora microcephala Britton								×			
Rynchospora ciliata Vahl	×										
Rynchospora corniculata (Lam.) A. Gray+											×
Rynchospora corniculata macrostachya (Torr.) Britton											
Rynchospora cymosa Ell.*+								×			
Rynchospora fascicularis (Mx.) Vahl			×								
Rynchospora filifolia A. Gray	×										
Rynchospora gracilenta A. Gray								×			
Rynchospora grayi Kunth	×										
Rynchospora inexpansa (Mx.) Vahl					×						
Rynchospora knieskernii Carey								×			
Rynchospora megalocarpa A. Gray	×										
Rynchospora miliacea A. Gray	×										
Rynchospora oligantha A. Gray							×				
Rynchospora pallida M. A. Curtis								×			
Rynchospora plumosa Ell	×										
Rynchospora rariflora Ell				×							
Rynchospora schoenoides (Ell.) Britton				×							
Rynchospora torreyana A. Gray								×			
Cladium effusum Torr					×						
Scleria torreyana Walp*								×			
Carex elliottii Schw & Torr	×										
Carex grandis Bailey+							×				
Carex littoralis Schwein									×		
Carex venusta Dewey	×										
Carex verrucosa Muhl					×						
Carex walteriana Bailey								×			
Peltandra sagittaefolia (Mx.) Morong	×				(?)						
Orontium aquaticum L											×
Sabal minor (Jacq.) Mohr	×										
Sabal palmetto Roem. & Schult	×										
Mayaca aubleti Mx	×										
Xyris ambigua Beyrich			×								
Xyris baldwiniana Roem. & Schult	×										
Xyris caroliniana Walt											×
Xyris communis Kunth+							×				

Northern limit of species—Continued.

Name of species	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Xyris fimbriata Ell								×			
Xyris torta J. E. Smith								×			
Eriocaulon compressum Lam.*								×			
Eriocaulon decangulare L.*								×			
Lachnocaulon anceps (Walt.) Morong			×								
Dupatya flavidula (Mx.) Kuntze		×									
Tillandsia usneoides L.*					×						
Commelina hirtella Vahl †								×			
Commelina nodiflora L.* †								×			
Tradescantia rosea Vent. †							×				
Juncus polycephalus Mx		×									
Juncus repens Mx.*							×				
Juncus roemerianus Scheele								×			
Juncus scirpoides Lam									×		
Juncus setaceus Rostk. †							×				
Pleea tenuifolia Mx	×										
Tofieldia glabra Nutt	×										
Tofieldia racemosa (Walt.) B. S. P								×			
Zygadenus glaberrimus Mx				×							
Zygadenus leimanthoides (Gray) Wats								×			
Lilium catesbaei Walt	×										
Aletris aurea Walt			×								
Yucca aloifolia L			×								
Yucca filamentosa L							×				
Yucca gloriosa L			×								
Smilax auriculata Walt	×										
Smilax lanceolata L	×										
Smilax laurifolia L								×			
Smilax tamnifolia Mx								×			
Smilax walteri Pursh								×			
Gyrotheca capitata (Walt.) Morong.*											×
Atamosco atamasco (L.) Greene					×						
Lophiola americana (Pursh) Coville								×			
Iris caroliniana S. Wats					×						
Habenaria cristata (Mx.) R. Br								×			
Habenaria integra (Nutt.) Spreng								×			
Habenaria nivea (Nutt.) Spreng							×				
Pogonia divaricata (L.) R. Br								×			
Gyrostachys odorata (Nutt.) Kuntze †					×						
Gyrostachys praecox (Walt.) Kuntze									×		
Listera australis Lindl									×		
Limodorum pauciflorum (Lindl.) Nash			×								
Hicoria aquatica (Mx.) Britton †					×						
Hicoria carolinae-septentrionalis Ashe							×				
Myrica cerifera L							×				
Quercus catesbaei Mx			×								
Quercus cinerea Mx					?						
Quercus digitata (Marsh.) Sudworth								×	?		
Quercus laurifolia Mx					×						
Quercus michauxii Nutt †							×				
Quercus nigra L. †							×				
Quercus phellos L. †									×		
Quercus virginiana Mill					×						
Ulmus alata Mx. †					×						
Parietaria debilis Forst			×								
Asarum arifolium Mx					×						
Aristolochia nashii Kearney					×						
Eriogonum tomentosum Mx		×									
Polygonum setaceum Baldw. †			×								
Sesuvium maritimum (Walt.) B. S. P.‡									×		
Arenaria caroliniana Walt									×		
Stipulicida setacea Mx	×										
Cabomba caroliniana A. Gray†	×										
Nymphaea sagittaefolia Walt. †		×									
Magnolia virginiana L											×
Clematis crispa L					×						
Ranunculus oblongifolius Ell. †					×						
Ranunculus pusillus Poir. †									×		
Cebatha carolina (L.) Britton †	×										
Persea borbonia (L.) Spreng					×		?				
Persea pubescens (Pursh) Sarg					×						
Malapoenna geniculata (Walt.) Coulter	×										
Benzoin melissaefolium (Walt.) Nees. †	×										
Cardamine arenicola Britton										×	

Northern limit of species—**Continued.**

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Sarracenia flava L			×								
Sarracenia rubra Walt	×										
Sarracenia variolaris Mx	×										
Drosera brevifolia Pursh	×										
Drosera filiformis Raf											×
Dionaea muscipula Ell			×								
Decumaria barbara L					×						
Itea virginica L								×			
Fothergilla carolina (L.) Britton		×									
Rubus cuneifolius Pursh +										×	
Rubus trivialis Mx. +					×						
Crataegus apiifolia (Marsh.) Mx. +					×						
Crataegus spathulata Mx. +					×						
Prunus angustifolia Marsh								×			
Prunus caroliniana (Mill.) Ait	×										
Chamaecrista aspera (Muhl.)			×								
Baptisia villosa (Walt.) Nutt				×							
Crotalaria purshii DC				×							
Crotalaria rotundifolia (Walt.) Poir					×						
Trifolium carolinianum Mx			×								
Psoralea pedunculata (Mill.) Vail					×						
Cracca ambigua (M. A. Curtis) Kuntze	×										
Cracca hispidula (Mx.) Kuntze		×									
Cracca spicata (Walt.) Kuntze							×				
Kraunhia frutescens (L.) Greene+		×									
Astragalus glaber Mx			×								
Indigofera caroliniana Walt			×								
Aeschynomene virginica (L.) B. S. P								×			
Zornia bracteata (Walt.) Gmel.*					×						
Stylosanthes riparia Kearney							×				
Meibomia arenicola Vail							×				
Meibomia stricta (Pursh) Kuntze								×			
Meibomia tenuifolia (Torr. & Gr.) Kuntze	×										
Lespedeza angustifolia (Pursh) Ell. +											×
Lespedeza hirta oblongifolia Britton								×			
Bradburya virginiana (L.) Kuntze*								×			
Galactia regularis (L.) B. S. P									×		
Galactia sessiliflora Torr. & Gr			×								
Erythrina herbacea L	×										
Rhynchosia erecta (Walt.) DC							×				
Rhynchosia simplicifolia (Walt.) Wood		×									
Rhynchosia tomentosa (L.) Hook. & Arn					×						
Zanthoxylum clava-herculis L					×						
Polygala brevifolia Nutt										×	
Polygala cymosa Walt							×				
Polygala lutea L									×		
Polygala ramosa Ell							×				
Croton maritimus Walt			×								
Crotonopsis linearis Mx.+								×			
Tragia urens L					×						
Jatropha stimulosa Mx					×						
Stillingia sylvatica L.+					×						
Euphorbia curtisii Engelm			×								
Euphorbia ipecacuanhae L.+										×	
Cyrilla racemiflora Walt.*					×						
Ilex ambigua (Mx.) Chapm											
Ilex decidua Walt.+					×						
Ilex glabra (L.) A. Gray											×
Ilex lucida (Ait.) Torr. & Gr											
Ilex vomitoria Ait						×					
Aesculus pavia L.+	×										
Berchemia scandens (Hill) Trelease+					×						
Vitis rotundifolia Mx.+							×				
Ampelopsis arborea (L.) Rusby*+			×								
Kosteletzkya althaeaefolia (Chapm.) Rusby*	×										
Kosteletzkya virginica (L.) A. Gray									×		
Stewartia malacodendron L											
Gordonia lasianthus L	×										
Ascyrum stans Mx									×		
Hypericum adpressum Bart											×
Hypericum aspalathoides Willd											
Hypericum densiflorum Pursh								×			
Hypericum fasciculatum Lam			×								
Hypericum galioides Lam							×				

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Hypericum pilosum Walt			×								
Hypericum virgatum Lam.†							×				
Triadenum petiolatum (Walt.) Britton								×			
Helianthemum corymbosum Mx	×										
Viola septemloba Le Conte											×
Passiflora incarnata L.†					×						
Opuntia opuntia (L.) Coult											×
Opuntia pes-corvi Le Conte			×								
Ammania koehnei Britton								×			
Lythrum lineare L								×			
Rhexia aristosa Britton								×			
Rhexia ciliosa Mx							×				
Rhexia glabella Mx			×								
Rhexia lutea Walt			×								
Rhexia mariana L.†								×			
Ludwigia alata Ell.†			×								
Ludwigia capitata Mx	×										
Ludwigia glandulosa Walt.†				×							
Ludwigia hirtella Raf								×			
Ludwigia linearis Walt									×		
Ludwigia microcarpa Mx			×								
Ludwigia pilosa Walt			×								
Ludwigia sphaerocarpa Ell											×
Ludwigia virgata Mx			×								
Jussiaea decurrens (Walt.) DC.†							×				
Jussiaea grandiflora Mx	×										
Oenothera humifusa Nutt‡								×			
Proserpinaca pectinata Lam											×
Myriophyllum pinnatum (Walt.) B. S. P.*†										×	
Aralia spinosa L.†									×		
Lilaeopsis lineata (Mx.) Greene											×
Eryngium virginianum Lam								×			
Ptilimnium capillaceum (Mx.) Hollick											×
Hydrocotyle canbyi Coult. & Rose								×			
Hydrocotyle verticillata Thunb											×
Centella asiatica (L.) Urban*							×				
Cornus stricta Lam					×						
Nyssa aquatica L.†					×						
Nyssa biflora Walt					×						
Dendrium buxifolium (Berg.) Desv								×			
Kalmia hirsuta Walt											
Leucothoë axillaris (Lam.) D. Don					×						
Leucothoë racemosa (L.) A. Gray											×
Pieris mariana (L.) Benth. & Hook										×	
Pieris nitida (Bartr.) Benth. & Hook.*					×						
Zenobia cassinefolia (Willd.) Pollard			×								
Xolisma foliosiflora (Mx.) Small					×						
Gaylussacia dumosa hirtella (Ait.) A. Gray					×						
Batodendron arboreum (Marsh.) Nutt.†					×						
Vaccinium crassifolium Andr	×										
Vaccinium virgatum Ait					×						
Vaccinium virgatum tenellum (Ait.) A. Gray					×						
Pyxidanthera barbulata Mx								×			
Hottonia inflata Ell											×
Bumelia lycioides (L.) Pers.†			×								
Symplocos tinctoria (L.) L' Hér							×				
Styrax americana Lam					×						
Styrax grandifolia Ait					×						
Styrax pulverulenta Mx		×									
Fraxinus caroliniana Mill.*					×						
Osmanthus americanus (L.) Benth. & Hook	×										
Gelsemium sempervirens (L.) Ait. f					×						
Cynoctonum mitreola (L.) Britton.*			×								
Cynoctonum sessilifolium (Walt.) Gmel			×								
Polypremum procumbens L.*†								×			
Sabbatia angustifolia (Mx.) Britton†	×										
Sabbatia brachiata Ell			×								
Sabbatia calycina (Lam.) Heller*					×						
Sabbatia campanulata (L.) Torr*											×
Sabbatia dodecandra (L.) B. S. P											×
Sabbatia elliottii Steud	×										
Sabbatia lanceolata (Walt.) Torr. & Gr								×			
Sabbatia paniculata (Mx.) Pursh					×						

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30′, N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30′, Conn. and R. I.	Latitude 42°, Mass.
Gentiana elliottii Chapm					×						
Gentiana porphyrio J. F. Gmelin								×			
Bartonia verna (Mx.) Muhl	×										
Limnanthemum aquaticum (Walt.) Britton								×			
Amsonia angustifolia Mx		×									
Trachelospermum difforme (Walt.) A. Gray							×				
Asclepias amplexicaulis Mx	×										
Asclepias lanceolata Walt								×			
Asclepias rubra L								×			
Asclepias tomentosa Ell		×									
Cynanchum palustre (Pursh) Heller			×								
Vincetoxicum carolinensis (Jacq.) Britton					×						
Vincetoxicum gonocarpos Walt.+					×						
Vincetoxicum hirsutum (Mx.) Britton							×				
Vincetoxicum suberosum (L.) Britton					×						
Dichondra evolvulacea (L. f.) Britton*					×						
Breweria aquatica (Walt.) A. Gray+	×										
Breweria humistrata (Walt.) A. Gray					×						
Breweria pickeringii (M. A. Curtis) A. Gray								×			
Ipomoea sagittata Cav.*			×								
Nama quadrivalvis (Walt.) Kuntze					×						
Verbena caroliniana Mx	×										
Lippia nodiflora (L.) Mx.*+			×								
Callicarpa americana L					×						
Teucrium nashii Kearney			×								
Trichostema lineare Nutt										×	
Physostegia denticulata (Ait.) Britton					×						
Macbridea pulchra Ell	×										
Clinopodium carolinianum (Sweet) Heller											
Mesosphaerum rugosum (L.) Pollard			×								
Koellia aristata (Michx.) Kuntze								×			
Koellia hyssopifolia (Benth.) Britton					×						
Physalis angulata L.*+					×						
Physalis viscosa L.*					×						
Monniera acuminata (Walt.) Kuntze							×				
Monniera caroliniana (Walt.) Kuntze								×			
Monniera monniera (L.) Britton*							×				
Gratiola pilosa Mx								×			
Gratiola sphaerocarpa Ell.*								×			
Micranthemum micranthemoides (Nutt.) Wettst.*								×			
Micranthemum orbiculatum Mx	×										
Buchnera elongata Sw			×								
Gerardia linifolia Nutt							×				
Schwalbea americana L											×
Utricularia biflora Lam+											×
Utricularia fibrosa Walt									×		
Utricularia juncea Vahl*					×						
Utricularia subulata L.*											×
Pinguicula elatior Mx	×										
Pinguicula lutea Walt	×										
Bignonia crucigera L.+					×						
Dianthera ovata Walt					×						
Oldenlandia uniflora L.*									×		
Diodia teres Walt+										×	
Diodia virginiana L								×			
Galium hispidulum Mx								×			
Galium tinctorium filifolium Wiegand					×						
Viburnum molle Mx											×
Viburnum nudum L									×		
Viburnum obovatum Walt											
Melothria pendula L.+					×						
Lobelia amoena Mx											
Lobelia amoena glandulifera A. Gray							×				
Lobelia canbyi A. Gray								×			
Lobelia glandulosa Walt					×						
Lobelia paludosa Nutt							×				
Sitilias caroliniana (Walt.) Raf							×				
Nabalus virgatus (Mx.) DC								×			
Iva frutescens L ‡											×
Iva imbricata Walt. ‡					×						
Vernonia oligophylla Mx			×								
Elephantopus nudatus A. Gray							×				
Sclerolepis uniflora (Walt.) Porter								×			
Eupatorium aromaticum L											×

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30' N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41°, 30' Conn. and R. I.	Latitude 42°, Mass.
Eupatorium capillifolium (Lam.) Small *					×						
Eupatorium coronopifolium Willd	×										
Eupatorium linearifolium Walt											×
Eupatorium leucolepis Torr. & Gr								×			
Eupatorium pinnatifidum Ell			×								
Eupatorium rotundifolium L									×		
Eupatorium semiserratum DC					×						
Eupatorium serotinum Mx. †							×				
Eupatorium torreyanum Short †								×			
Eupatorium verbenaefolium Mx											×
Lacinaria elegans (Walt.) Kuntze											
Lacinaria graminifolia (Walt.) Kuntze					×						
Lacinaria graminifolia pilosa (Ait.) Britton								×			
Lacinaria tenuifolia (Nutt.) Kuntze	×										
Trilisa odoratissima (Walt.) Cass	×										
Trilisa paniculata (Walt.) Cass			×								
Carphephorus bellidifolius (Mx.) Torr. & Gr	×										
Carphephorus tomentosus (Mx.) Torr. & Gr			×								
Heterotheca subaxillaris (Lam.) Britton *†							×				
Chrysopsis graminifolia (Mx.) Nutt							×				
Chrysopsis mariana (L.) Nutt									×		
Chrysopsis pilosa (Walt.) Britton			×								
Chondrophora nudata (Mx.) Britton								×			
Solidago elliottii Torr. & Gr											×
Solidago fistulosa Mill								×			
Solidago petiolaris Ait. †			×								
Solidago puberula pulverulenta (Nutt.) Chapm			×								
Solidago stricta Ait. *								×			
Solidago tortifolia Ell					×						
Euthamia caroliniana (L.) Greene †											×
Sericocarpus bifoliatus (Walt.) Porter			×								
Aster concolor L											×
Aster coridifolius Mx											×
Aster gracilis Nutt								×			
Aster paludosus Ait.*			×								
Aster purpuratus Nees	×										
Aster squarrosus Walt	×										
Aster tenuifolius L. ‡											×
Erigeron quercifolius Lam		×									
Erigeron vernus (L.) Torr. & Gr					×						
Doellingeria humilis (Willd.) Britton								×			
Baccharis angustifolia Mx	×										
Baccharis glomeruliflora Pers	×										
Baccharis halimifolia L. ‡											×
Pluchea camphorata (L.) DC.*											×
Pluchea foetida (L.) B. S. P.*								×			
Pterocaulon pycnostachyum Ell	×										
Silphium asteriscus L. †							×				
Silphium compositum Mx	×										
Borrichia frutescens (L.) DC.* ‡					×						
Helianthus angustifolius L									×		
Coreopsis angustifolia Ait			×								
Coreopsis delphinifolia Lam											
Coreopsis gladiata Walt			×								
Coreopsis rosea Nutt											×
Bidens coronata (L.) Fisch											
Actinospermum uniflorum (Nutt.) Barnh	×										
Marshallia graminifolia (Walt.) Small		×									
Helenium vernale Walt		×									
Arnica acaulis (Walt.) B. S. P							×				
Senecio tomentosus Mx								×			
Carduus repandus (Mx.) Pers				×							
Carduus virginianus L. †											
Chaptalia tomentosa Vent		×									

RELATIONSHIP TO OTHER FLORAS.

Let us now turn to the broader relationships of the flora. The total number of indigenous genera of Pteridophta and Embryophyta of which representatives were collected or observed in the Dismal Swamp region is 330. Of these there are—

Endemic in eastern North America (east of the Rocky Mountains)	26
Endemic in North America (including Mexico and the Antilles)	17
Endemic in America (North and South)	27
Endemic in eastern North America and eastern (chiefly extratropical) Asia	26
Endemic in the Northern Hemisphere	44
	136
Of wider distribution	194
	330

The distribution of the less widely dispersed genera is shown in the following table, the names of monotypic genera being preceded by an * and those of genera almost but not quite confined to the particular category being followed by a ±:

Distribution of genera of limited range.

Eastern North America.	North America. Mexico, and the Antilles.	America, North and South.	Eastern North America and eastern Asia.	Northern Hemisphere.
Triplasis.	Taxodium.	Philotria (Elodea).	* Zizania.	Osmunda. ±
Eatonia.	Yucca.	Uniola.	Tipularia.	Woodwardia. ±
* Dulichium.	Proserpinaca.	Distichlis. ±	Saururus.	Juniperus.
Peltandra.	Xolisma (Lyonia).	Tillandsia.	Nelumbo.	Ammophila.
Uvularia.	Monarda.	Pontederia.	Magnolia.	Acorus.
Limodorum (Calopogon).	Koellia (Pycnanthemum).	Atamosco (Zephyranthes).	Liriodendron.	Lilium.
Hicoria.	Pentstemon. ±	Sisyrinchium.	Decumaria.	Polygonatum.
Asimina.	Conopholis.	Phoradendron.	Itea.	Iris.
* Sassafras.	Houstonia.	Bradburya (Centrosema).	Hamamelis.	Juglans.
* Sanguinaria.	Sitilias (Pyrrhopappus).	Kosteletzkya.	Liquidambar.	Populus.
Aronia.	Chrysopsis.	Ascyrum.	Falcata (Amphicarpaea).	Ostrya.
Baptisia.	Euthamia.	Opuntia.	Apios.	Carpinus.
Cyrilla.	Sericocarpus.	Oenothera.	Parthenocissus.	Alnus. ±
* Sarothra.	Ionactis.	Gaylussacia.	Triadenum (Elodes).	Fagus.
Hudsonia.	Iva.	* Polypremum.	Ptilimnium (Discopleura).	Castanea.
Lechea. ±	Rudbeckia.	Gonolobus.	Nyssa.	Quercus.
* Decodon.		Verbena. ±	Azalea. ±	Ulmus.
Rhexia.		Mimulus. ±	Pieris.	Morus.
Kalmia. ±		Gerardia.	Epigaea.	Comandra.
* Oxydendrum.		Bignonia.	Chionanthus.	Asarum.
Sabbatia.		Willughbaeya (Mikania).	Gelsemium.	Sagina.
Bartonia.		Baccharis.	Trachelospermum.	Ammodenia (Honkenya).
Dasystoma.		Parthenium.	* Phryma.	Nymphaea (Nuphar).
Adopogon (Krigia)		Borrichia.	Mitchella.	Cakile.
Lacinaria (Liatris).		Helianthus.	Nabalus.	Spiraea.
Boltonia.				Fragaria. ±
Silphium.				Potentilla. ±
				Geum. ±
				Agrimonia. ±
				Rosa.
				Malus.
				Amelanchier.
				Crataegus. ±
				Cercis.
				Euonymus.
				Circaea.
				Cicuta.
				Cornus. ±
				Chimaphila.
				Oxycoccus.
				Fraxinus.

An analysis of these columns shows that more than two-thirds of the genera occurring in the Dismal Swamp region which are endemic in eastern North America are small ones, numbering 1 to 6 species, and of these a half dozen are monotypic. Of the 26 genera common to eastern North America and eastern Asia 2 are monotypic, 9 have 2 species each, and 4 consist of 3 species each. The others, with one exception (Azalea), number 4 to 10 species each. On the other hand, the genera which are widely distributed in America, or throughout the Northern Hemisphere, are mostly of considerable size. The majority, which have still more extensive ranges, include several of the largest of the genera of vascular plants. It is generally admitted that in small genera of comparatively restricted distribution we have to do in many cases with very old and failing types. On the other hand, the large, widely dispersed genera are dominant and in many cases comparatively modern types.

The total number of species of pteridophytes and embryophytes collected or observed is, roughly, 720, of which about 100 have been introduced by the direct or indirect agency of man from other regions, while the remainder are indigenous. Of the indigenous species over 500 are endemic in extratropical North America, the great majority in the country east of the Rocky Mountains and a large percentage in the Austroriparian area. The nonendemic but indigenous species occur likewise in the following regions:

1. *Tropical Zone.*		
(*a*) Of both hemispheres	9	
(*b*) Of the New World alone	50	
		59
2. *North Temperate Zone.*		
(*a*) Europe alone	2	
(*b*) Europe and Asia	23	
(*c*) Asia alone	6	
		31
Total		90

1. *Tropical Zone.*

(*a*) BOTH HEMISPHERES.

Cyperus haspan.
Cyperus esculentus.
Spirodela polyrhiza.
Hydrocotyle umbellata.
Hydrocotyle ranunculoides.
Centella asiatica.
Dichondra evolvulacea.
Physalis angulata.
Monniera monniera.

(*b*) THE NEW WORLD ALONE.

Polypodium polypodioides.
Triglochin striata.
Sagittaria lancifolia.
Erianthus saccharoides (Cuba).
Paspalum distichum.
Paspalum compressum.
Panicum gibbum (Cuba).
Cenchrus tribuloides macrocephalus.
Uniola paniculata.
Eleocharis mutata.
Eleocharis ochreata.
Stenophyllus capillaris.
Fimbristylis autumnalis.
Fimbristylis castanea.
Fimbristylis laxa.
Fimbristylis spadicea.
Rynchospora cymosa (Cuba).
Scleria pauciflora (Cuba).
Juncus repens (Cuba).
Quercus virginiana (Cuba).
Lepidium virginicum.
Chamaecrista fascicularis.
Bradburya virginiana.
Phyllanthus caroliensis.
Parthenocissus quinquefolia (Cuba).
Sida spinosa.
Rotala ramosior.
Oenothera laciniata.
Proserpinaca palustris (Cuba).
Pieris nitida (Cuba).
Samolus floribundus.
Fraxinus caroliniana (Cuba).
Gelsemium sempervirens.
Polypremum procumbens.
Sabbatia calycina.
Trachelospermum difforme.
Cuscuta arvensis.
Physalis viscosa.
Linaria canadensis.
Oldenlandia uniflora (Cuba).
Cephalanthus occidentalis (Cuba).
Ambrosia artemisiaefolia.
Eupatorium capillifolium.
Willugbaea scandens.
Leptilon canadense.
Pluchea camphorata.
Gnaphalium purpureum.
Borrichia frutescens.
Bidens bipinnata.
Erechtites hieracifolia.

2. *North Temperate Zone.*

(*a*) EUROPE ALONE.

Ammophila arenaria.
Drosera intermedia.

(*b*) EUROPE AND ASIA.

Osmunda regalis.
Dryopteris spinulosa.
Pteris aquilina.
Asplenium filix-foemina.
Lycopodium inundatum.
Typha angustifolia.
Homalocenchrus oryzoides.
Alopecurus geniculatus.
Festuca rubra.
Carex canescens.
Scirpus lacustris.
Acorus calamus.
Juncoides campestre.
Atriplex hastata.
Salicornia herbacea.
Salsola kali.
Ammodenia peploides.
Tissa marina.
Isnardia palustris.
Circaea lutetiana.
Chimaphila umbellata.
Bidens cernua.
Potentilla monspeliensis.

(c) ASIA ALONE.

Zizania aquatica.
Pogonia ophioglossoides.
Ostrya virginiana.
Triadenum virginicum.
Monotropa uniflora.
Phryma leptostachya.

The equatorial origin of the dominant element in the flora of the Dismal Swamp region is strikingly illustrated by the fact that of its nonendemic indigenous species twice as many occur in tropical America as in the temperate regions of the Old World.

Of introduced plants that have become naturalized in the Dismal Swamp region, 96 species were collected or observed, although the total number occurring there is undoubtedly considerably greater. The origin of these species is as follows:

Europe	76
Tropical America	9
Tropical Asia	6
Eastern extratropical Asia	3
Extratropical North America	2
Total	96

In the following table is given a list of the families of Pteridophyta and Embryophyta which are represented in the flora of the Dismal Swamp region, with the number of genera and species of each which there occur. Owing to the fragmentary nature of the collections of Thallophyta which were made, it has seemed best to omit these, and likewise the Bryophyta, from the table. It is not to be supposed that nearly the total number of species, or even of genera, which actually occur in the region are here included. But it is believed that the enumeration embraces a large majority of both the species and the genera in the groups included. Only such species as are certainly or very probably indigenous are here enumerated.

The object of the table is to present the distribution of the flora by families, so that those which are dominant in the region will at once appear. The twelve largest families are as follows:

Family.	Number of genera.	Number of species.	Family.	Number of genera.	Number of species.
Poaceae (Gramineae)	32	83	Ericaceae	8	13
Cyperaceae	14	69	Scrophulariaceae	8	12
Compositae	28	68	Juncaceae	2	12
Viciaceae (Papilionaceae)	15	26	Orchidaceae	6	11
Fagaceae	3	15	Nepetaceae	8	11
Rosaceae	7	15	Rubiaceae	6	11

The prominence of such families as Fagaceae, Rosaceae, Ericaceae, Juncaceae, Nepetaceae, and, in Cyperaceae, the genus Carex, in the Dismal Swamp region is sufficient evidence that there is a strong boreal element in its flora. On the other hand, there is a great development of other Cyperaceae (notably Cyperus and Rynchospora), which belong essentially to the warmer parts of the world; of Viciaceae (chiefly belonging to tribes and even genera which are widely distributed in the tropics); and of Scrophulariaceae (principally in the largely tropical tribes Gratioleae and Gerardieae). In Compositae, the Eupatorieae, a mainly tropical tribe, are abundantly represented, while the Anthemideae and Senecionideae, which are largely boreal tribes, are almost wanting, the former being represented only by introduced species. Furthermore in the largest family, that of the true grasses, Poaceae (Gramineae), one-half of the indigenous species belong to the two largely tropical tribes Andropogoneae and Paniceae.

The respectively chiefly tropical and chiefly extratropical families of the flora are indicated in the table, the former by an affixed (T), the latter (E). Families of which the majority of species are American are designated (TA) or (EA) as the case may be. Extratropical families that are more strongly developed in the northern than in the southern hemisphere are marked (EB). It may be mentioned that the number of families and of genera recognized in the following list is somewhat larger than would be the case if the limits of families and genera, as defined in most standard systematic works, had been followed.

Summary of families, genera, and species, with data of distribution.

No.	Family.	Genera.	Species.	No	Family.	Genera.	Species.
1	Osmundaceae	1	2	62	Rutaceae (T)	1	1
2	Polypodiaceae	6	8	63	Polygalaceae	1	3
3	Lycopodiaceae	2	3	64	Euphorbiaceae (T)	6	9
4	Pinaceae (EB)	4	5	65	Callitrichaceae	1	1
5	Typhaceae	2	3	66	Anacardiaceae (T)	1	5
6	Naiadaceae	1	1	67	Ilicaceae (T)	1	5
7	Alismaceae	2	2	68	Celastraceae (T)	1	1
8	Vallisneriaceae (T)	1	1	69	Aceraceae (EB)	1	1
9	Poaceae	32	83	70	Impatientaceae (T)	1	1
10	Cyperaceae	14	69	71	Rhamnaceae (T)	2	2
11	Araceae (T)	3	3	72	Vitaceae (T)	2	5
12	Lemnaceae	1	1	73	Malvaceae (T)	2	2
13	Xyridaceae (TA)	1	2	74	Hypericaceae	3	7
14	Eriocaulaceae (T)	1	1	75	Cistaceae (EB)	3	6
15	Bromeliaceae (TA)	1	1	76	Violaceae (E)	1	7
16	Commelinaceae (T)	1	1	77	Passifloraceae (TA)	1	2
17	Pontederiaceae (T)	1	1	78	Cactaceae (EA)	1	1
18	Juncaceae	2	12	79	Lythraceae (TA)	3	8
19	Liliaceae	6	6	80	Melastomaceae (TA)	1	2
20	Smilaceae (T)	1	5	81	Onagraceae (E)	7	10
21	Amaryllidaceae (T)	2	2	82	Haloragidaceae	2	3
22	Dioscoreaceae (TA)	1	1	83	Araliaceae (T)	1	1
23	Iridaceae	2	4	84	Apiaceae (EB)	7	9
24	Orchidaceae (T)	6	11	85	Cornaceae (EB)	2	6
25	Saururaceae	1	1	86	Clethraceae (TA)	1	1
26	Juglandaceae (EB)	2	5	87	Pyrolaceae (EB)	1	2
27	Salicaceae (EB)	2	4	88	Monotropaceae (EB)	1	1
28	Myricaceae	1	2	89	Ericaceae (E)	8	13
29	Betulaceae (EB)	3	3	90	Vacciniaceae (EB)	5	8
30	Fagaceae (EB)	3	15	91	Primulaceae (EB)	2	8
31	Ulmaceae	2	4	92	Ebenaceae (T)	1	1
32	Moraceae (T)	1	1	93	Symplocaceae (T)	1	1
33	Urticaceae (T)	2	2	94	Styracaceae (T)	1	1
34	Loranthaceae (T)	1	1	95	Oleaceae	2	2
35	Santalaceae (T)	1	1	96	Loganiaceae (T)	2	2
36	Aristolochiaceae (TA)	2	3	97	Gentianaceae (E)	3	6
37	Polygonaceae (EB)	2	7	98	Apocynaceae (T)	2	3
38	Chenopodiaceae (E)	2	2	99	Asclepiadaceae (T)	2	4
39	Phytolaccaceae (T)	1	1	100	Convolvulaceae (T)	2	3
40	Aizoaceae (T)	1	1	101	Cuscutaceae	1	2
41	Alsinaceae (E)	3	3	102	Boraginaceae	1	1
42	Nymphaeaceae (TA)	3	3	103	Verbenaceae (T)	3	3
43	Ranunculaceae (EB)	3	4	104	Nepetaceae (E)	8	11
44	Berberidaceae (EB)	[illegible]	[illegible]	105	Solanaceae (T)	2	4
45	Magnoliaceae (EB)	2	[illegible]	106	Scrophulariaceae (E)	8	12
46	Anonaceae (T)	1	1	107	Bignoniaceae (T)	3	3
47	Lauraceae (T)	3	3	108	Orobanchaceae (EB)	1	1
48	Papaveraceae (EB)	[illegible]	[illegible]	109	Pinguiculaceae	1	4
49	Brassicaceae (EB)	3	3	110	Acanthaceae (T)	2	2
50	Droseraceae (E)	[illegible]	[illegible]	[illegible]	Phrymaceae (EB)	1	1
51	Saxifragaceae (EB)	2	2	112	Plantaginaceae (E)	2	2
52	Hamamelidaceae	2	2	113	Rubiaceae (T)	6	11
53	Platanaceae (EB)	[illegible]	1	[illegible]	Viburnaceae (EB)	3	5
54	Rosaceae (EB)	[illegible]	15	115	Valerianaceae (E)	1	2
55	Pyraceae (EB)	4	7	116	Cucurbitaceae (T)	1	1
56	Amygdalaceae	1	3	117	Campanulaceae (E)	1	1
57	Cassiaceae (T)	3	4	118	Lobeliaceae (T)	1	5
58	Viciaceae	15	28	119	Cichoriaceae (EB)	5	6
59	Geraniaceae (E)	1	1	120	Ambrosiaceae (EA)	2	3
60	Oxalidaceae (T)	1	5	121	Carduaceae	28	66
61	Linaceae	1	4				

AGRICULTURAL PRODUCTS.

In order that we may discuss intelligibly the connection between the character of the native vegetation and that of the soil, especially as affording an indication of the probable agricultural value of the latter, it is necessary to describe briefly the principal crops of the region, and to indicate the methods employed in cultivating them, as well as the leading types of soil which are best adapted to each (Pls. LXXVI, LXXVII). The chief cultivated plants of the country have already been enumerated in the description of the plant formations, but there only in order to complete the picture of the plant covering of the region.

The most important of the crop plants of the Dismal Swamp region can be classified as follows: (1) garden vegetables or truck crops, (2) cereals, (3) cotton, (4) forage plants, (5) peanuts, (6) fruits.

TRUCK CROPS.

There is now an almost continuous strip of land along the coast of the United States, from Massachusetts to southern Florida, which is devoted to the production of market-garden vegetables, or "truck." The country about Norfolk was one of the first in this belt to adopt the trucking industry upon a large scale, and it is still equal in importance to any other area, excepting, perhaps, that about New York City. The different table vegetables can be brought to maturity several weeks earlier in this mild climate than in the vicinity of the large Northern cities which afford the principal market for them. By the extension of the trucking industry much farther south than southeastern Virginia, it has become possible to supply Northern tables with most of the favorite vegetables in fresh condition throughout the year. But this has not destroyed the market for truck raised about Norfolk, because, while any particular vegetable grown, for example, in South Carolina or in Florida reaches the Northern cities much earlier than the Norfolk crop, there is a period following the gathering of the more Southern and preceding the maturity of the more Northern crop, during which the region around Norfolk has a monopoly of the market for that particular vegetable. Consequently there is a constant succession from South to North, during each season, in the maturing and marketing of each of the principal garden vegetables.

As has been mentioned in the chapter on soils, the land which is best fitted for the cultivation of these crops lies immediately upon or very near the coast. There are several reasons for this: First, the tempering effect upon the climate of the neighborhood of the sea, which greatly diminishes the danger of loss from late spring and early fall frosts; second, the light, sandy, warm, and well-drained character of the soil, which facilitates the process of forcing; finally, the convenience for cheap transportation by water. In the Dismal Swamp region, as elsewhere, it is the land bordering salt water or within a very few miles of it that is most largely used for growing truck. No statistics later than those given in the reports of the Eleventh Census could be obtained as to the extent of country occupied by these crops, and it would be difficult to form a close estimate, owing to the fact that the truck farms are scattered over a long and much indented shore line, and also because the area planted varies, although not, perhaps, to any great extent, from year to year.

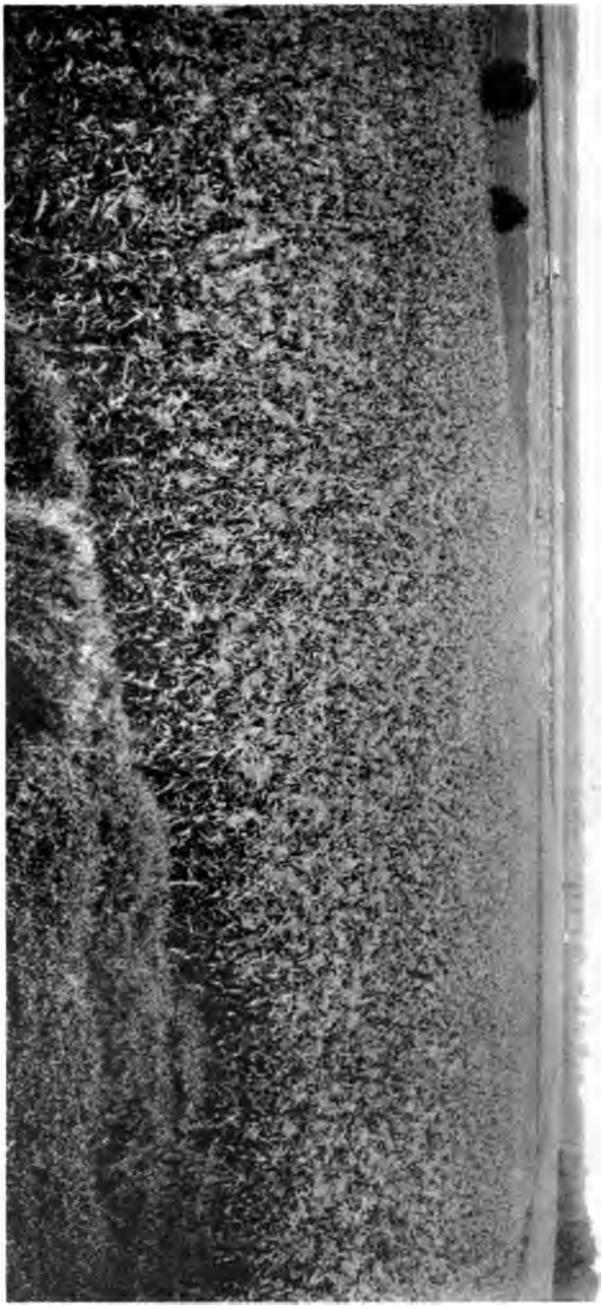
The largest areas of truck land in the region border upon the Elizabeth River and its branches, especially the southern and western branches; but there are also numerous large truck farms immediately north and east of Norfolk and south of Portsmouth and Berkley. Certain truck crops, notably potatoes and strawberries, are largely and successfully grown in the heavier soils farther inland along all the railways which enter Norfolk, but for most vegetables the light soils along the coast are decidedly best suited. The sands of the outer coast, bordering Chesapeake Bay and the Atlantic Ocean, are of course not adapted to cultivation, as they are too much exposed to winds laden with sand or with spray.

On the southern border of the region, along Albemarle Sound, truck crops are grown to some extent, but are of secondary importance; e. g., near Edenton, N. C., where cotton and peanuts are the staple agricultural products. South of the Dismal Swamp region, near Newbern, N. C., is another of the most important and best known trucking areas along the coast. Here most of the crops mature about ten days earlier than around Norfolk. The well-drained, warm, loamy lands lying between the Neuse and Trent rivers, immediately west of this town, are almost entirely devoted to crops of garden vegetables.

The sandy or light loamy soils of the plain about Norfolk are not naturally very fertile, but they are warm and easily worked, which makes them eminently fitted for bringing crops to early maturity. Their original poverty in various elements of plant food is compensated by the use of enormous quantities of fertilizers, and this is a source of great expense to the trucker, whose initial outlay is much more considerable than that of other farmers. The method of cultivation of most truck crops is highly intensive. In addition to heavy fertilizing, much time and labor must be spent upon most of the crops. Moreover, the gathering of them requires the employment of many laborers, as the work is slow and the crop can not be allowed to stand upon the ground after it has matured. This is particularly true of strawberries, but applies to all the truck crops.

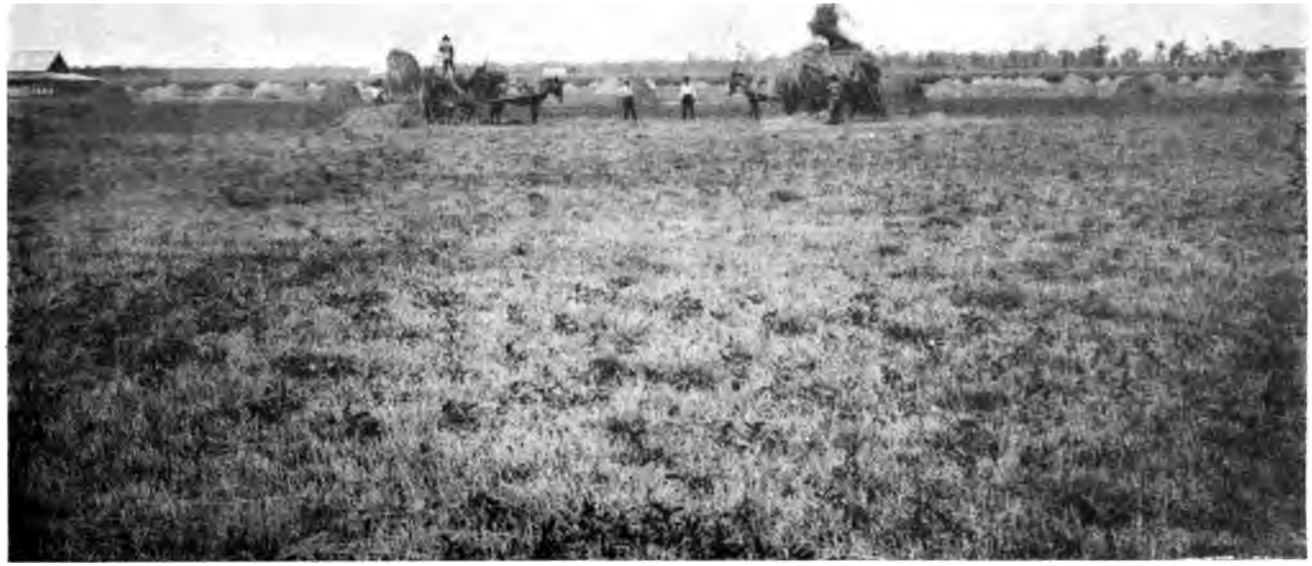
The principal garden vegetables grown in the country about Norfolk are, in about the order in which they mature, kale, spinach, lettuce (these three marketed in winter), radishes, asparagus, strawber-

PLATE LXXVI



HORSE TOOTH CORN ON LAND CLEARED FROM THE DISMAL SWAMP AT WALLACETON, VA.

THE HELIOTYPE PRINTING CO., BOSTON.



TIMOTHY MEADOW ON LAND CLEARED FROM THE DISMAL SWAMP AT WALLACETON, VA.

THE HELIOTYPE PRINTING CO., BOSTON.

ries (these three are spring crops), peas, beans, squash, cabbage (these four are marketed in early summer), cucumbers, potatoes, tomatoes, watermelons, cantaloupes, and sweet potatoes. The largest acreage is in potatoes, the next in cabbage, the third in strawberries. Crops of comparatively small importance are beets, turnips, and onions. Sweet corn is raised in a small way for local consumption, but the difficulty of transportation precludes its being an important truck crop.

The cultivation of celery has been successfully undertaken upon the rich black-gum lands which have been reclaimed from the wooded swamps. Only one crop can be made in a season on account of the warmth of the climate, but the product is said to equal in quality the best Michigan celery.

The Norfolk region is well known for its potato crop. Potatoes are grown not only on the light soils near the coast, where they mature early, but also on a large scale in the heavier, rich soils along the eastern border of the Dismal Swamp, where the average yield is said to be about 80 barrels per acre. Two crops are often raised on the same land in one season. The first is marketed, while the second-crop potatoes are smaller and are partly used for "seed," being usually gathered before they have fully matured, which insures great vitality. The "seed" potatoes are largely shipped to Northern and Eastern growers, many of whom prefer them to native-grown "seed." They are generally too small to cut in pieces, but are "bled" by slicing off a small piece before planting.

Strawberries are cultivated extensively, the Thompson and the Hoffman being the favorite varieties. The plants are often set out the first year in rows with cabbages, which protect them while young. The greater part of the crop is marketed by the middle of May, the berries being picked in the field into the boxes in which they are sold. The boxes are then packed in crates, 60 boxes to the crate, small sheds being often erected in the fields for the purpose of packing. The pickers are negroes and receive usually 2 cents, but, toward the end of the season, sometimes only 1½ cents a box for their work. A strawberry field at picking time, alive with men, women, and children gathering the berries, is an animated sight.

Peas and beans are usually gathered in large baskets, and the taking off of these crops also requires many laborers. Most of the other truck crops can be gathered more rapidly, and fewer hands are needed for them.

On the southern border of the Dismal Swamp region other crops are usually more important than truck. Around Edenton, however, the light, warm, loamy soils, which are best suited to cotton, are also well adapted to sweet potatoes, tomatoes, etc., and they are raised in considerable quantity.

At Newbern, N. C., the season is usually nearly two weeks earlier than about Norfolk, and the former usually holds the market for each important truck crop for about that length of time. But a spring with unusually rapidly rising temperature will largely obliterate the difference and bring Newbern into competition with Norfolk.

The principal garden vegetables grown at Newbern are potatoes, cabbages, strawberries, tomatoes, peas, beans, squash, rutabagas, cantaloupes, sweet potatoes, eggplant, cucumbers, asparagus, and lettuce. Of these, as at Norfolk, potatoes rank first in acreage, cabbages second, and strawberries, of which the cultivation is rapidly increasing, third. Pumpkins are also raised in the vicinity of Newbern, the usual practice of planting them with corn being followed. Of several of the early summer vegetables a second crop is often made in the fall—e. g., potatoes, string beans, and peas. The second crop of potatoes is partly used for seed and the remainder is marketed for table use. Potatoes are largely grown near Newbern on land that has been reclaimed from swamps, but the product of such soil is said to be often dark in color, while the Early Rose potatoes, which are grown in the typical truck soils of the region—light, sandy loams—have a fine white color. Potatoes are extensively grown in the bottom land of the Neuse River, but there the soil is sandy rather than silty.

Cabbages are grown in the vicinity of Newbern in the light loams as well as in heavier soils, but the latter are best suited to this crop. When cabbages are to be put into the light lands, compost is usually applied to serve as a mulch. The ordinary yield of this crop at Newbern is about 200 barrels to the acre.

Strawberries are successfully grown both on the light loams and on the somewhat heavier and richer "gallberry" lands. This crop is usually more highly cultivated than at Norfolk, care being taken to keep the rows constantly free from weeds. Quality rather than quantity is aimed at in the endeavor to hold a high-grade market for this section. The Thompson is a popular variety, and lately the Brandywine has come into favor with some growers. The "vines" live through the winter about Newbern without protection, but are usually covered in early spring with a mulch of pine straw, which tends to prevent the plants being buried in the sand during heavy rains as well as to protect them against late frosts. At Norfolk some growers believe that the presence of weeds among the strawberry plants serves as a partial protection during the winter.

Lettuce is sown at Newbern in frames, and the plants are then set out in large beds, 16 feet wide and over 200 feet long. Two crops are usually made, one being marketed between Thanksgiving Day and Christmas and the second some weeks later.

The amount of fertilizer necessary in order to make a good truck crop of course varies somewhat with the character of the soil and the crop, but is always considerable. About one ton to the acre is the usual quantity for the typical light soils. The black gallberry lands near Newbern require something like 1,800 pounds of potash for potatoes and 1,000 for berries. These crops also demand much labor and care for planting, cultivating, gathering, and marketing. An experienced grower at Newbern estimated that one team of mules or horses to every 10 acres is the minimum requirement for a truck farm. In addition to the expense of producing a crop, the uncertainty of the yield, and especially of the market, must be taken into consideration. It can be safely said that no branch of agriculture in the United States makes heavier demands upon the courage, the industry, and the intelligence of the farmer than does truck growing.

CEREALS.

The only important cereal and, next to the truck crops, the most important agricultural product of the Dismal Swamp region is corn. Corn is largely raised on the truck soils, after one or two earlier crops of garden vegetables have been removed. But land of this character is too light and has too little bottom to yield a first-class crop, even if the corn were planted early enough to make its full growth. The stalks are usually short and thin and the total leaf surface is small and has not the fine green color which corn at its best should have. Consequently the ears are neither large nor full, and the crop hardly meets the local demand.

The heavier lands of the interior, in Norfolk and Princess Anne counties, are naturally better for cereals than are the coast soils, having a greater content of silt or of clay and therefore holding water better. But in many places they have been exhausted by long cultivation in corn or cotton, without the practice of intelligent rotation.

The finest corn land of the region is unquestionably that which has been cleared from the wooded swamps. Extensive bodies of such land occur along the Dismal Swamp Canal, and are largely in corn. When first cleared, the best type of black-gum land brings, without application of lime or fertilizers, 80 bushels of corn to the acre. The stalks are often 10, 12, and sometimes 16 feet high. Even after several years of cultivation such land, with little or no treatment, continues to yield 40 bushels. One field, said to have been in corn almost continuously for at least forty years, still produces 20 to 25 bushels of corn to the acre. It has been allowed to lie idle sometimes for a year or two, but rotation has not been practiced. Most of the corn raised on the largest farm in the section (about 800 acres in extent) is exported to Germany, where it is used for seed. It is a White Dent with a very long grain, and is known as "Horse-tooth Corn" (Pl. LXXVI).

Swamp lands at Newbern are usually planted in corn immediately after clearing, without the application of fertilizers. The first year two or three crops are made. Then the stumps are burnt off and cultivation is begun. Land of this character at Newbern will produce

75 barrels per acre of early potatoes and in the same season about 5 barrels of corn.

Wheat is said to have been successfully grown near Suffolk and elsewhere in the region, and is still raised in small quantities here and there on the inland soils with clayey bottom and considerable water content, but it is hardly worth mentioning as a crop of the region. The summers are doubtless too hot for the profitable cultivation of this cereal.

Oats are grown to a considerable extent and to fair advantage, chiefly in the stiffer upland soils at some distance from the coast. Barley and rye are also occasionally raised in land of similar character. The last three cereals are used in this region as forage plants. Oats and barley are frequently sown with field peas.

Numerous small fields of upland rice are to be seen near the north shore of Albemarle Sound, where it is grown on the same light, loamy soil that is preferred for cotton. Of course this variety is not cultivated with periodical sluicing of the fields, as is common rice, which is a staple crop farther south, near Wilmington.

COTTON.

This great staple is grown in a small way in the lower part of Norfolk and Princess Ann counties, Va., but on land which is for the most part pretty well worn out. In the most southern part of the Dismal Swamp region, however, e. g., about Edenton, N. C., cotton is the principal crop, and thrives on the light, brown, loamy soils. Near Newbern it is also an important product, being grown to advantage on the truck soils. It is often sown after a crop of peas, potatoes, or other early truck has been removed from the land. Cotton does well also on the richer gallberry land in the neighborhood of Newbern.

FORAGE PLANTS.

The ordinary meadow grasses are not cultivated to any noteworthy extent about Norfolk. The comparatively small number of live stock raised in the region can be supplied with green pasturage during a great part of the year, thanks to the long moist summers and the mild winters.

In winter and early spring cattle are allowed to graze chiefly on the young leaf shoots of the "reeds" or cane (*Arundinaria macrosperma* and *A. tecta*) which abound in every moist woodland. The broom-sedges (species of Andropogon, especially *A. virginicus*) afford considerable natural pasturage during the spring months. In early summer the various Leguminosae (especially species of Meibomia and Lespedeza), which abound in open woodlands, afford some grazing to cattle. The native partridge pea (*Chamaecrista fascicularis*) and the introduced Japan clover (*Lespedeza striata*), both of which are occasionally abundant on sandy roadsides, are much relished by stock.

What hay is needed is largely afforded by crab grass (*Syntherisma* (*Panicum*) *sanguinale*), which springs up abundantly and spontaneously in every truck field after the crop has been removed. If the land is then allowed to lie idle, two crops of "crab hay" can be secured before the fall-sown truck is put in. The first crop makes excellent forage, while the second is inferior, and is chiefly useful for bedding. It takes about ten days to cure crab grass thoroughly. After it has been mown the stubble is usually plowed under, but sometimes is left standing until the next crop of truck is to be sown, when the crab-grass stubble is burnt over.

Cowpeas are the principal cultivated forage crop in this section, and are usually planted with corn, but sometimes alone. Here, as elsewhere through the southeastern States, this legume is more highly valued for restoring exhausted soils than any other, as its roots penetrate deeper than those of clover, and it is better adapted to the long, hot summer. It is said in one year to render "kind" and "mellow" soils which were stiff and almost unworkable. When used for this purpose the peas are plowed under. If the next crop is to be potatoes, however, the tops of the vines should first be cut, as otherwise the potatoes are liable to "scab." Cowpea hay is often cured in ricks. The vines, either alone or mixed with crab grass, are stacked upon wooden frames which consist of horizontal arms fastened to a vertical pole, and are thus left to dry. In the Dismal Swamp region, and near Newbern, the "Black-Eye" pea is the variety most frequently grown. At Newbern the "Lady" pea also is sometimes used.

German millet is frequently cultivated near Norfolk as a forage plant and grows well in the light truck soils. The use of oats, rye, and barley has already been mentioned.

Timothy is successfully cultivated on the heavier soils, especially those reclaimed from the Dismal Swamp (Pl. LXXVII). One field of about 22 acres, at Wallaceton, which had been cultivated for about five years, part of the time in potatoes, and had therefore been treated with lime and fertilizers, yielded as much as 2 tons of timothy hay to the acre.

Clovers, red and alsike, are frequently grown on the heavier inland soils, where oats, barley, and rye thrive best. Crimson clover is often sown upon somewhat lighter soils.

It is probable that at some distance from the seashore, by selecting soils which have a stiff clay bottom and therefore hold considerable water, the cultivation of meadow grasses and clovers could be made profitable if the land is given a preliminary liming. The luxuriant growth of Kentucky blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), redtop (*Agrostis alba vulgaris*), and meadow fescue (*Festuca elatior*), as well as clovers and vetches, at the edges of ditches along the shell roads would indicate that a little lime is the principal requirement for a good meadow in this region.

PEANUTS.

Norfolk is the principal point at which peanuts are prepared for the market and are shipped to various parts of this country and abroad. There are several peanut factories in the city where the nuts are received, sorted, and graded, the better kinds polished and those for confectioners' trade shelled.

Peanuts are not grown to any noteworthy extent east or north of the Dismal Swamp, but on the higher lands west of Suffolk the acreage in this crop is considerable. On the north side of Albemarle Sound, near Edenton, peanuts rank next to cotton as a staple crop, and nowhere do they grow better than on the warm, brown loams which are best suited to the cultivation of cotton.

FRUITS.[1]

The principal cultivated fruits of the Dismal Swamp region, strawberries, watermelons, and canteloupes, have already been discussed under the head of truck; no others are of first importance.

Orchard fruits, with a few exceptions, do not appear to be well adapted to conditions in this section. Apples are frequently planted, but the trees are small and the fruit is usually inferior. However, certain summer apples, especially the Red Astrakhan, do quite well on the heavier soils, and orchards of limited size are not rare. Pears (Keifer) are less planted than apples. Peaches do not seem to thrive as a rule, and receive little attention, although one fruit grower at West Norfolk reports 50 acres of peach orchard. Figs are often planted near dwellings, especially in the southern part of the region, and mature their fruit freely. Grapes, especially the scuppernong, a derivative of the ubiquitous native muscadine, are much grown in arbors. There are a few small vineyards in the region, the varieties cultivated being chiefly derivatives of *Vitis labrusca*.

The growing of bramble fruits is very limited. Blackberries are raised here and there, one grower having as much as 15 acres. The most popular variety in this region is the "Wilson." An obstacle to success with this fruit is the prevalence of the disease known as "double blossom." It is possible that the native sand blackberry, whose sweet, well-flavored fruit might be susceptible of improvement, would be found immune from this disease when cultivated. The cultivation of dewberries should also prove a profitable industry. Plantations of raspberries occur, but these are very few and very small. It would seem highly desirable to increase the production of fruits of this class in the Dismal Swamp region, as the demand for them is constantly increasing. As is the case with the truck crops, berries shipped from Norfolk would have the market largely to themselves for a period of about two weeks each year.

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[1] For much of my information in regard to the fruits of this section I am indebted to Mr. W. A. Taylor, assistant pomologist of the Department of Agriculture.

Some of the wild fruits of the region are quite palatable. Worthy of mention are: The muscadine grape (*Vitis rotundifolia*), wild currants or service berry (*Amelanchier botryapium*), Chicasaw plum (*Prunus angustifolia*), the wild strawberry (*Fragaria virginiana*), blackberries (*Rubus cuneifolius*, the sand blackberry, *R. nigrobaccus*, the common high blackberry, and *R. villosus*, the dewberry), and huckleberries (*Vaccinium corymbosum*, *V. vacillans*, *Gaylussacia frondosa*, and especially *G. resinosa*). Edible, but less pleasant to the average taste, are the papaw (*Asimina triloba*), the persimmon (*Diospyros virginiana*), the hackberry (*Celtis occidentalis*), and the maypop (*Passiflora incarnata*). The cranberry (*Oxycoccus macrocarpus*) also grows wild in the region. Its cultivation here is probably not feasible, owing to the length and heat of summer and the difficulty of properly controlling the water supply. The cold soil of the Dismal Swamp, where peat moss grows abundantly, would meet the requirements of this fruit were it possible to retain these conditions after the timber has been cleared away. However, it is not likely that the cultivation of this fruit, except, possibly, in limited quantities for the local market, would prove remunerative, because of the difficulty of preserving it for the winter market. The berries would naturally mature much earlier here than in New Jersey. It is also a question whether cranberries would not be even more liable to "scald" and other diseases than is the case farther north.

OTHER CROPS.

Tobacco is not cultivated to any important extent in the Dismal Swamp region, although it is occasionally raised by the negroes in small patches for their own use. It grows very well upon the light truck soils, but would not be as profitable as the garden vegetables. Near Newbern its cultivation is increasing, wrapper leaf being the variety preferred. There are now two tobacco warehouses in that town. However, tobacco is in Virginia and North Carolina a crop of the Piedmont rather than of the Coastal Plain region.

Small fields of sorghum are seen here and there in the region, but it is probably grown only for home consumption. The cane, cut into small pieces, is ground in a very primitive little mill, the power being furnished by a mule, which is hitched to the beam that serves as a crank.

AGRICULTURAL WEEDS.

The most injurious weeds of the Dismal Swamp region are mainly such as are common elsewhere in Atlantic North America, by far the greater number being introduced from Europe.

In spring the truck lands, especially fields of strawberries, are often badly infested with chickweed or winter grass (*Alsine media*). This weed appears to be stimulated by the use of fertilizers, so that land which has been in cultivation for some time is usually much more badly infested than newly cleared land. Sheep sorrel (*Rumex acetosella*), wart cress (*Coronopus didymus*), and little barley (*Hordeum pusillum*) are very common and noxious weeds of truck fields in the spring. Owing to the greater difficulty of eradicating them, these small spring weeds are more abundant among strawberries than among other truck crops. In summer nut grass (*Cyperus rotundus*) is sometimes a bad weed, but it is not as common here as it is farther south. Near Newbern it is considered the worst weed of the country, as it spreads by means of its peculiar underground tubers, and is consequently difficult to eradicate. Bermuda grass (*Capriola* (*Cynodon*) *dactylon*) is also frequently a troublesome pest, as its creeping stems strike root anywhere, and it is almost impossible to destroy it with a hoe. Owing to the high cultivation practiced and the frequency with which one crop is removed and another is put into the ground, truck lands are not subject to being overrun by weeds as are fields of other crops, especially corn.

Corn fields, if the soil is thin and the crop is not well cultivated, are apt to be invaded by woody plants, especially sassafras (*Sassafras sassafras*), persimmon (*Diospyros virginiana*), and sumach (*Rhus copallina*). In richer soils cockleburs (*Xanthium strumarium*) and morning glories (*Ipomoea purpurea* and *I. hederacea*) are often bad weeds among the corn. Corn fields that have been recently cleared from the Dismal Swamp are much infested by the reed or cane (*Arundinaria macrosperma*), which spreads underground by means of its strong, creeping rootstocks. Drainage and cultivation for a few years, however, will remove this pest.

In old fields which are more or less neglected or are allowed to lie fallow for a time, certain chiefly native plants often become troublesome. If the land is rather low and badly drained, the showy yellow-flowered butter weed (*Senecio tomentosus*) is very common in the spring. In late summer and fall, large plants, chiefly of the sunflower and the grass families, are abundant. Dog fennel or hogweed (*Eupatorium capillifolium*), the white daisy (*Aster ericoides*), ragweed (*Ambrosia artemisiaefolia*), horse weed (*Leptilon* (*Erigeron*) *canadense*), crab grass (*Syntherisma* (*Panicum*) *sanguinale*), sprouting crab grass (*Panicum proliferum*), barnyard grass (*Panicum crus-galli*), and yellow foxtail (*Chaetochloa glauca*) are the most important. Land which is left to itself still longer is usually taken possession of by the common broomsedge (*Andropogon virginicus*), and among the tufts of this grass seedling pines often spring up in great numbers.

Fields of red clover are often badly infested in late spring and early summer by the broom rape (*Orobanche minor*), which grows as a parasite on the roots of the clover plants and greatly reduces their vitality. Grass meadows, especially of timothy, sometimes contain great quantities of the prickly horse nettle (*Solanum carolinense*), which considerably reduces the value of the hay.

Weeds which are largely confined to roadsides and waste ground need not be discussed here, as the more important species have already been enumerated in the description of the plant formations.

RELATION OF THE NATIVE PLANT GROWTH TO THE CHARACTER OF THE SOIL.

It is known to farmers the world over that in the nature of the virgin growth upon a body of land they have the best possible indication of its agricultural value. An experienced person can take his stand on a hilltop and, looking off across the country, indicate the quality of the soil here or there by the forest that grows out of it. Where he sees a slope covered with a heavy growth of black walnut and yellow poplar (tulip) he knows that the soil will be rich and deep, well suited to wheat. Where tall sycamores and elms flourish on the bank of a stream, there will surely be found fat alluvial soil, the best of all land for growing corn. The Southern planter recognizes promising cotton land by the growth of oaks, dogwood, myrtle, etc., which it bears.[1] On the other hand, he is well aware that a soil which supports only pine, with very little undergrowth, is too sandy and thin to be valuable in its natural state, but, when heavily fertilized, is excellent for forcing early vegetables.

In a general way such facts as these are known and practically applied wherever the soil is tilled. Little, however, has been done to put this knowledge upon a scientific basis. It would undoubtedly be most helpful to the farmer if he could find out how far the value of this test of uncleared land can be relied upon. He would like to know just how sharp a line can be drawn between soils of different chemical composition, texture, and drainage by carefully noting the wild growth which they bring forth.

It was largely in the hope of being able to throw light upon this problem that the present survey was undertaken. The Dismal Swamp region was selected for the preliminary investigation because it was known that here conditions are less complicated than in many other sections. The evenness of the surface of the Coastal Plain and the absence of abrupt changes of level would naturally tend to simplify the premises from which deductions were to be drawn. As will presently be seen, this very lack of diversity, while removing some difficulties from the survey, was an obstacle to obtaining very striking results.

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[1] In his Catalogue of the Natural Orders of Plants Inhabiting the Vicinity of the Santee Canal, South Carolina (Proc. Am. Assoc. Adv. Sci., vol. 3, p. 5, 1850), H. W. Ravenel writes, "On the highlands bordering these swamps, where the best cotton lands are found, hickories, dogwood (*Cornus florida*), oaks, etc., constitute the principal vegetation."

COMPARATIVE INFLUENCE OF DRAINAGE AND CHEMICAL FACTORS.

In the Dismal Swamp region, if we consider only lands that give some promise of agricultural value, variations in drainage constitute the most important soil differences. In other parts of the country chemical composition of the soil plays a leading part. For example, limestone and freestone soils are often very sharply differentiated within a limited area. Such differences are of little importance in the country we are considering. Only the salt-marsh and sand-dune soils, and those of the fresh-water wooded swamps previous to being drained, present important peculiarities in their chemical composition. Needless to say, these three formations are worthless from an agricultural point of view, so long as they remain in their natural condition. Omitting them from the discussion, the problem becomes chiefly one of water content, depending in great part upon the fineness of subdivision exhibited by the soil. When this is coarse, the soil is sandy and well drained. When finely divided, it becomes silty or clayey, holding water longer and in greater quantity.

Now the respective characteristics of vegetation upon a sandy well-drained soil and upon clayey wet land are much less striking, and the transition from one to another is more gradual and less easy to define than is the case where important chemical differences exist. The line between vegetation that grows in a soil rich in lime and that upon a lime-poor soil is often so abrupt and sharply defined as to be easily recognizable at a distance. Not only size, habit, hairiness, etc., differ markedly in the same species when growing upon one or the other kind of soil, but there are a number of species which prefer limestone soils, while others show a strong aversion to soil that contains much lime. Thus the systematic makeup of the vegetation changes to a large extent as we pass from one soil to the other.[1]

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[1] In the United States the distribution of plants upon soils rich or poor in lime (which means chiefly calcium carbonate, $CaCO_3$) has not received the attention which it deserves. Undoubtedly interesting results await the student of this important problem in soil chemistry and plant geography. In Europe much work has been done in the line indicated. Especially in France the matter has been approached from the standpoints of chemistry, physics, and geology, as well as of botany. The agricultural journals, and writers upon forestry, have devoted much space to its consideration. Several attempts have been made to segregate the indigenous plants of various regions as confined to limestone soils, preferring lime, preferring freestone, confined to freestone, or indifferent. Bonnier and others have indicated, however, that a hard and fast classification is not easily attainable, as species which are "lime-loving" in one chain of mountains are

In the exceptional cases noted above, easily recognizable changes in the vegetation coincide with important differences in the chemical quality of the soil. Near the sea, in what we call the maritime formations, the soil contains a much larger percentage of common salt (NaCl) than is present in ordinary soils. This substance acts upon the great majority of plants as a poison if it occurs in the soil in considerable quantity—1 per cent or, for many species, even less. Consequently the vegetation of the dunes and beach is sparse and is composed of but few species, most of which are peculiarly adapted to salt-impregnated soil and air, and are not found in normal inland soils. Even more strikingly is this the case with the salt marshes, where the soil is overflowed with brackish water at every high tide. Their vegetation is extremely different from that which occupies ordinary, moderately well drained soils which contain but a small trace of salt.

Peculiar chemical conditions are also found in the soil of the swampy forests so long as they remain in their natural condition. Chief among these peculiarities are exceeding richness in vegetable matter and poverty in oxygen, to which is due the presence of much humic acid. The soil is sour. In addition, we have the physical peculiarity of a very high water content, the soil being normally saturated. Given such conditions and it is not strange that the vegetation, notably the forest growth, of these swamps is sharply differentiated from that on adjacent, not swampy soils, even where the latter are moderately moist.

Both the maritime and the swamp soils are agriculturally worthless in their natural condition. It is not likely that any treatment could be devised which would render arable the salt marshes or the beach

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sometimes "lime-avoiding" in another. Some of the principal works dealing with the subject are:

Unger. Über den Einfluss des Bodens auf die Verteilung der Gewächse. 1836.

Thurman. J. Essai de phytostatique appliqué à la chaîne du Jura et aux contrées voisines. 1849.

De Candolle. A. Geographie botanique raisonné. Vol. 1, pp. 264, 422–447. 1855.

Bonnier, G. Quelques observations sur les relations entre la distribution des phanérogames et la nature chimique du sol. Bull. Soc. Bot. de France, vol. 26, pp. 338–341. 1879.

Contejean. C. Géographie botanique. Influence du terrain sur la végétation. 1881.

Vallot, J. Recherches physico-chimiques sur la terre végétale et ses rapports avec la distribution géographique des plantes. 1883.

Fliche et Grandeau. Recherches chimiques et physiologiques sur la brùyere commune. Ann. de la Science Agronomique (1884), vol. 1, 394–411. (Two other papers by the same authors are there cited—De l'influence de la composition chimique du sol sur la végétation du pin maritime. Ann. de Chimie et de Physique, ser. 4, vol. 29. 1873. De l'influence de la composition chimique du sol sur la végétation du châtaignier, op. cit., ser. 5, vol 2.

Ramann, E. Forstliche Boden-Kunde und Standortslehre, pp. 365, 366. 1893.

Warming. E. Lehrbuch der ökologische Planzengeographie, pp. 63, 75. 1896.

Schimper, A. F. W. Pfanzengeographie, 105–118 (1898.)

and dune areas, at least without great expense; but by careful drainage a great part of the wooded swamps can be converted into highly valuable land. In this process, however, the soil loses the chemical and physical peculiarities just enumerated, and if afterwards permitted to lie fallow it becomes rapidly overgrown with the ordinary not swampy forest vegetation of the region. Unless it reverts to its original condition as to drainage, such land has ceased forever to belong to the swampy forest formation.

TYPES OF ARABLE SOILS.

Two leading types of soil are easily distinguishable in that part of the Dismal Swamp region which is occupied by neither salt marshes, sand strand, nor wooded swamps.

1. Soils of a light, sandy texture, warm, and capable, when cleared, of thorough drainage. These are the "truck soils," which are largely devoted to the growing of garden vegetables, the chief industry of the region. They usually occur on or very near tide water.

2. Soils with a relatively high content of silt or clay, and consequently colder and more retentive of water. These are mostly inland soils, and as has already been pointed out, are ill adapted to many truck crops, but give good returns, under proper management, with grasses and some cereals.

The truck lands are at present by far the most valuable of the region, and with them we shall therefore chiefly concern ourselves. What is the character of the original forest and undergrowth on soils of this class? Is it sufficiently well marked to enable us to say with confidence, after an examination of the native vegetation alone, "Here we have or have not a good truck soil?"

NATIVE VEGETATION OF TRUCK LANDS.

Before answering this question it may be well to describe briefly the more important growth upon a number of representative tracts of forest where the question could be satisfactorily answered in the affirmative after an inspection of the soil itself and of the appearance of crops in adjacent fields.

1. On one of the largest and best truck farms along the Western branch of Elizabeth River, near Norfolk, the following growth was noted: Short-leaf pine (*Pinus taeda*), 40 to 50 feet high, intermixed with much hardwood—water oak (*Quercus nigra*), willow oak (*Quercus phellos*), white oak (*Quercus alba*), sweet gum (*Liquidambar styraciflua*), and sour gum (*Nyssa sylvatica*). Undergrowth dense, composed of red maple (*Acer rubrum*), sourwood (*Oxydendrum arboreum*), huckleberry (*Gaylussacia frondosa*), pepper bush (*Clethra alnifolia*), sassafras, sumac (*Rhus copallina*), spikenard tree (*Aralia spinosa*), small cane (*Arundinaria tecta*), etc. The presence of several of these plants, especially of the water oak, red maple, and

small cane, indicates a soil that is naturally not well drained, as is very generally the case in the region.

2. Along the Southern branch of Elizabeth River, near Berkley: Forest of small short-leaf pines (20 to 30 feet high), mixed with sweet gum, water oak, Spanish oak (*Quercus digitata*), sourwood, etc. Undergrowth moderately dense, of sumac (*Rhus copallina*), sweet gum, and gallberry (*Ilex glabra*). Nearer the water where the soil is still lighter and sandier, myrtle (*Myrica carolinensis*), becomes important in the undergrowth, while sumac disappears.

3. Lamberts Point, near Norfolk: Timber chiefly large short-leaf pine (sometimes 80 feet high and 4 feet through), mixed with some sweet gum (also of large dimensions), and small trees or bushes of various oaks (willow, white, water, and quercitron (*Quercus velutina*), holly (*Ilex opaca*), sour gum (*Nyssa sylvatica*), pepper bush (Clethra), bay (*Persea pubescens*), etc. Greenbrier (*Smilax rotundifolia*), and muscadine grape (*Vitis rotundifolia*) are abundant.

4. Suffolk: Forest of small short-leaf pines, averaging 40 feet in height. Undergrowth especially heavy near the border of the forest, composed of sourwood (very abundant), sweet gum, myrtle (*Myrica carolinensis*), holly, gallberry, tulip tree (*Liriodendron tulipifera*), Spanish oak, white oak, water oak, huckleberry (*Gaylussacia frondosa*), and blueberry (*Vaccinium virgatum tenellum*).

5. Edenton: Rather heavy growth of large short-leaf pine (*P. taeda*), some of the trees being 80 feet high and 4 feet in diameter. Other trees are tulip (*Liriodendron tulipifera*), sweet gum, sourwood (*Oxydendrum*), white oak, black cherry (*Prunus serotina*), and red cedar (*Juniperus virginiana*), all small. The undergrowth is made up of dwarfed plants of the trees mentioned, together with myrtle, spikenard tree (*Aralia spinosa*), holly, sassafras, *Callicarpa americana*, and various climbing plants, trumpet creeper (*Tecoma radicans*), yellow jessamine (*Gelsemium sempervirens*), muscadine grape (*Vitis rotundifolia*), and greenbrier (*Smilax rotundifolia*). This soil, as the growth indicates, has rather more body than is necessary or even advantageous for growing most truck crops. The neighboring fields were planted in cotton which was in excellent condition and indicated a soil well adapted to that staple.

6. Edenton, near the preceding tract: Pines small and giving place to hardwoods, chiefly tulip tree and Spanish oak, with a scattered undergrowth of persimmon (*Diospyros virginiana*), sumac, sourwood, sweet gum, spikenard tree, yellow jessamine, etc. Here the soil was lighter and sandier than in No. 5, and therefore better adapted to truck.

The problem of ascertaining just what plants are useful as indicators of a good truck soil is not a simple one. As we have already remarked, it is the water content of the soil, depending very largely upon its fineness of texture, that chiefly determines the distribution of plant life in the Dismal Swamp region. The dunes and salt marshes are of course exceptions, but these can be left out of the discussion, which concerns only soils that are likely to be of agricultural value.

Now, there exists an element of uncertainty, which made itself evident at the outset of the investigation, in the very considerable versatility as to habitat which many plants exhibit in this region. Woody plants are elsewhere usually quite sensitive to differences of water content in the soil. Thus, in regions where the surface of the country is more broken and exhibits a greater variety of elevation the red maple is rarely found outside of swamps, while such trees as sweet gum, willow oak, buttonwood, sand-bar willow, and blue beech are confined to the banks of streams. In the Dismal Swamp region, however, all these plants are met with in the driest soils of that section, even occurring upon the sand dunes of the coast. Sweet gum and red maple are present almost everywhere, usually in the greatest abundance.

Sassafras, sumac (*Rhus copallina*), persimmon, sourwood (*Oxydendrum*), and spikenard tree (*Aralia spinosa*) are all common plants in the Piedmont and the mountain regions of the Southern States, as well as in the Coastal Plain. But while in the more elevated parts they are most characteristic of dry uplands, near the coast they occupy very wet as well as comparatively very dry soils, even thriving in all but submersed ground in the Dismal Swamp. As partially explaining this peculiarity of distribution, however, it must be borne in mind that arid soils, or even soils that remain constantly dry for any considerable period, are unknown in the region we are describing. The difference between the wettest and the driest land is here much less sharp than in districts having a more perfect drainage.

Still, with every allowance for the absence of sharp limits between the vegetation of soil that is moderately heavy and wet, but not swampy, and that which is relatively light and dry, we are, nevertheless, able to recognize a type of native growth which serves fairly well as an indication of a soil of the latter character and one therefore that is well adapted to truck.

Short-leaf pine (*Pinus taeda*) is always present in such land if it has retained its original vegetation. This tree does not, however, reach its largest size on the truck soils, but in land having considerably more bottom, such as usually occurs farther from salt water. Where the original growth of pine has been disturbed hardwoods tend to replace it, and these are also usually present as undergrowth in the more open pine forest. Various oaks, especially Spanish oak (*Quercus digitata*), white oak (*Q. alba*), red oak (*Q. rubra*), quercitron (*Q. velutina*), and the so-called water oak (*Q. nigra*) are usually present. Sweet gum (*Liquidambar styraciflua*) is almost always found upon land that is adapted to truck crops, often forming the principal undergrowth. The presence of dogwood (*Cornus florida*) in any considerable quantity is a safe indication of a good soil of this type. Holly (*Ilex opaca*), black walnut (*Juglans nigra*), and hickory are trees whose presence indicates a type of soil that is richer than the lightest pine lands, yet highly esteemed by truck farmers.

A variety of shrubs are found in good truck land. Myrtle (*Myrica carolinensis*) is often a very important feature of the undergrowth. Although common on the dunes, where the soil is agriculturally worthless, its presence in the pine forests denotes a promising truck soil. Gallberry (*Ilex glabra*), while frequent in land that is too heavy to meet the requirements of truck farming, is occasionally common on high-grade soils which are well adapted to some truck crops, especially potatoes and strawberries. Near Newbern a type of soil which is sandy but richer in organic matter than most truck soils and to which we have already referred is known as "gallberry land" because of the predominance of this shrub upon it.

Sweet bay (*Persea pubescens*) resembles gallberry in its distribution upon both light and heavy soils. The presence of a number of other shrubs in considerable quantity among the undergrowth may be taken as fairly conclusive evidence of a good truck soil. These are: *Callicarpa americana*, sourwood (*Oxydendrum arboreum*), persimmon (*Diospyros virginiana*), spikenard tree (*Aralia spinosa*), huckleberry or blue tangle (*Gaylussacia frondosa*), blueberry (*Vaccinium virgatum tenellum*), and deerberry (*Vaccinium stamineum*). Less characteristic of this type of soil are sassafras and sumac (*Rhus copallina*). Muscadine grape (*Vitis rotundifolia*) and summer grape (*V. aestivalis*) are much more abundant on this than on heavier soils. Round-leaved greenbrier (*Smilax rotundifolia*) and yellow jessamine (*Gelsemium sempervirens*) are very often present, but are also common in heavier land.

VEGETATION OF LANDS UNSUITED TO TRUCK FARMING.

The fact has already been noted that certain plants, such as red maple (*Acer rubrum*), willow oak (*Quercus phellos*), and small cane (*Arundinaria tecta*), while normally swamp-loving species, are found in the Dismal Swamp region upon a great variety of soils. The presence of any or all of them among the undergrowth does not necessarily indicate a soil too heavy for truck, but is good evidence that the natural drainage is for some reason deficient. But wherever red maple and black gum in numbers grow to be good-sized trees it can be concluded with safety that here the soil is too heavy and too rich in organic matter for purposes of truck farming. Similarly the occurrence of beech or of cow oak (*Quercus michauxii*) of any considerable size betrays a clay content in the soil that precludes the successful prosecution of this branch of farming. There are a number of plants, e. g., cypress (*Taxodium distichum*), juniper (*Chamaecyparis thyoides*), black gum (*Nyssa biflora*), cotton gum (*N. uniflora*), rattan (*Berchemia volubilis*), big cane (*Arundinaria macrosperma*), poison dogwood or boarwood (*Rhus vernix*), cottonwood (*Populus heterophylla*), laurel-leaved greenbrier (*Smilax laurifolia*), sweet bay (*Magnolia virginiana*), etc., whose presence betrays at once that the soil is too rich in organic matter to be at all suited to "trucking" as the industry is at present practiced.

While the trees and shrubs enumerated in the preceding paragraph show that the soil on which they grow is not adapted to forcing garden vegetables to early maturity, with the exception of juniper they by no means indicate a worthless soil. The heavier clayey, but not swampy, lands, which are mostly found at some distance from tide water, can be made to yield excellent crops of oats, clover, timothy, cowpeas, and other forage plants. It is to be strongly recommended that more attention be paid in the Dismal Swamp region to growing forage crops and raising cattle. Truck farming, although yielding large returns to a few successful growers, is already overcrowded, and is becoming more so every year. It is no uncommon thing in the extensive trucking areas along the coast for a large part of the berry crop to be left on the vines; and much of the potato crop remains in the ground because overproduction has brought the market price down to a figure where it no longer pays to gather the crop. Meanwhile a large part of the beef and even the dairy products consumed in the region are imported from the North and West.

While some lands are fairly well adapted to wheat, cotton, and tobacco, it is much to be doubted whether this region can successfully compete with others in the production of any of these crops. Much of the heavy interior soils are now in corn, and in the lower part of Norfolk and Princess Anne counties, Va., a noteworthy amount of cotton is raised. As a rule neither crop gives good results, chiefly because the land has been worn out by long cultivation in one or the other crop, without the practice of intelligent rotation. Greater attention to clover and meadow grasses, as well as more diligent cultivation, would go far to restore them. There are some farms in that part of the region which afford admirable object lessons of what can be accomplished by this treatment. But as a rule the interior lands are in sorry contrast to the highly cultivated truck farms that border tide water.

A final word should be said concerning the swamp lands, which are more fully discussed in the chapter on "Soils." These are of two types—the peaty juniper soil and the rich black-gum land. The first type, which does not occur in any noteworthy area outside the main borders of the Dismal Swamp, is characterized by a native growth of "juniper" or white cedar (Chamaecyparis). According to all testimony, it is agriculturally valueless. "Black-gum land" is so called from the principal tree which it bears when in its virgin state, the black gum (*Nyssa biflora*). Most of it is covered with a heavy forest composed of this tree, red maple (*Acer rubrum*), some (formerly much) cypress (*Taxodium distichum*), blue ash (*Fraxinus caroliniana*), etc. When cleared and well drained such land yields much better crops of corn than can be had on any other soil of the region. The corn crop of the Dismal Swamp lands is likely to prove peculiarly valuable, as the product is mostly shipped abroad. Being within 10 to 20 miles of a seaport that is hardly surpassed on our coast, this region has a great advantage over the better known corn-producing country of the Mississippi Valley. The variety chiefly grown on the swamp soils is known as horsetooth corn. It is a white dent which possesses an unusually long kernel, and is largely exported to Germany for use as a seed corn.

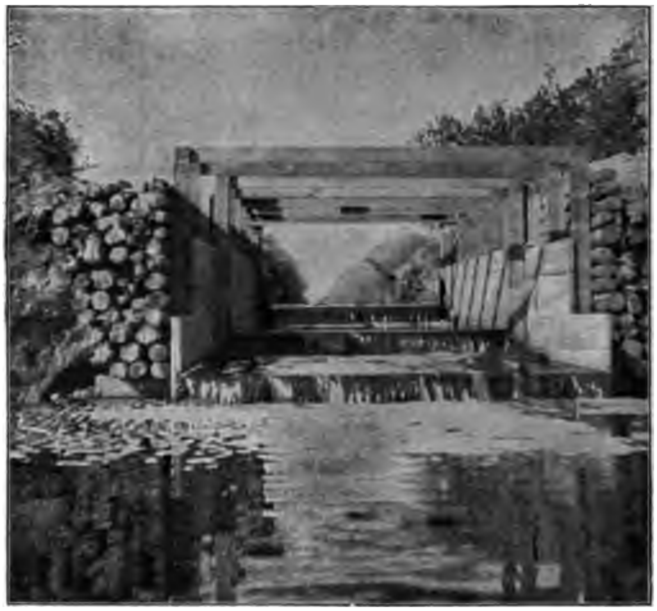

FIG. 85.—Mouth of main drainage ditch emptying into the Dismal Swamp Canal, Wallaceton, Va.

Irish potatoes and cabbage also give excellent results on such land. It has lately been demonstrated that celery can be successfully and profitably grown in black-gum land. And last, but not least, it is probably better suited to the establishment of permanent meadows than any other type of soil in the Dismal Swamp country.

ILLUSTRATIVE QUOTATIONS.

It may not be out of place to quote in conclusion a few published descriptions of the natural growth on different types of soil in other parts of the United States east of the Mississippi. They will 'e to illustrate how generally this means of disting soils is employed.

The younger Michaux gives an inter

his "Voyage à l'ouest des monts Alleghanies," published in 1804. I quote pages [illegible] to [illegible] of the English translation, "Travels to the westward of the Allegheny Mountains," which was printed in the following year:

> In these two states [Kentucky and Tennessee] they appreciate the degree of fertility of the land by the different species of trees which grow upon them; thus when the sale of a lot of land is advertised, they are careful to specify that such or such kind of trees grow on such or such parts, which is sufficient information to the purchaser. This rule, however, admits of an exception with respect to the *Barrens*, the soil of which, as I have mentioned, is very fertile and on which, nevertheless, there are found the *Scrubby oak*, Quercus nigra, and the *Juglans hickory*, which in the forest are evidences of the worst soil. Supported by this mode of estimating the fecundity of the soil by the nature of the trees which it produces, I shall mention a very remarkable observation which I made as soon as I arrived in this State. In Kentucky and Cumberland[*] independently of a few trees which are peculiar to these countries, the mass of the forests in lands of the first class, is composed of those species which are very rarely met with to the east of the mountains in the most fertile soils. These species are principally the following: *Cerasus virginiana*, cherry tree; *Juglans oblonga*, white walnut; *Pavia lutea*, buck eye; *Fraxinus alba, nigra, cerulea*, white, black, and blue ash; *Celtis folliis villosis*, hackberry; *Ulmus viscosa*, slippery elm; *Quercus imbricaria*, black-jack oak; *Guilandina dioica*, coffee tree: *Gleditsia triacanthos*, honey locust, and *Annona triloba*, papaw, which rises to the height of 30 feet. These three last species, in particular, denote the richest lands. In cool mountainous places and by the sides of the rivers which have not steep banks, there are also found the *Quercus macrocarpa*, over-cup white oak, the acorns of which are as large as a hen's egg; the *Acer saccharinum*, sugar maple: the *Fagus sylvatica*, beech; and also the *Platanus occidentalis*, plane: the *Liriodendrum tulipifera*, white and yellow tulip tree, and the *Magnolia acuminata*, cucumber tree, the three last of which attain to a circumference of 18 or 20 feet. The plane, as has been mentioned before, grows to a larger size.
>
> In the lands of the second class are found *Fagus castanea*, chestnut; *Quercus rubra*, red oak; *Quercus tinctoria*, quercitron: *Laurus sassafras*, sassafras; *Diospiros virginiana*, persimmon: *Liquidambar styraciflua*, sweet gum; *Nyssa villosa*, gum tree, a tree which neither yields gum nor resin, as its name seems to imply.
>
> Those of the third class which are generally arid and mountainous, scarcely produce any but the black and red oak; the *Quercus prinus montana*, rocky oak, some pines, and sometimes Virginian cedars.

Mr. W. W. Ashe (Bull. N. C. Geol. Survey, vol. 5, pp. 14 to 16) describes as follows the natural vegetation on different soils in eastern North Carolina:

> The timber over the entire section is, on the highlands, largely of two species of pine; one, the loblolly pine (*Pinus taeda* L.), more confined to the counties north of the Neuse River and to the moister soil: the other, the long-leaf pine (*Pinus palustris* Mill.), to those south of this river and to the drier, more sandy soil. Beneath these trees, where the soil is not too dry and sandy, is a lower growth of small white and post oaks, dogwood, haws, and the narrow-leaved crab apple, while where the soil is very sandy and dry there grows, either with the long-leaf Pine or where it has been removed, a small worthless oak, the sand black-jack or

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[*] "In the United States the name of Cumberland is given to that part of Tennessee which lies west of the mountains of that name."

barren oak (*Quercus catesbaei* Michx.), and, less frequently, the high-ground willow oak (*Quercus cinerea* Michx.). This oak is also a small tree and indicates the most barren soil. Besides the pines just referred to, there are two others found with them, the short-leaf [yellow] pine (*P. echinata* Mill.), an uncommon tree except on dark loam or gravelly soil along the western and northern limits of this section, and the savanna pine (*P. serotina* Michx.), a knotty, unsymmetrical tree occurring from Virginia southward along the margins of "pine barren" ponds or scattered in small clumps over the open savannas and marsh lands. These few species form the chief growth of the higher lands.

The swamp lands, with a total area of about 3,500 square miles, have a very characteristic and varied growth. Bordering these swamps are water and willow oaks, with the evergreen loblolly bay and sweet bay. Farther in them are huge swamp chestnut oaks (*Quercus michauxii* Nutt.), elms, maples, beech, holly, and tall rosemary pines (*P. taeda* L.). These lands constitute the *oak flats*, areas which are under water only during the wettest seasons of the year. They have usually a good soil and can be easily drained.

Where the water is deeper in the swamps and remains longer grow the cypress, sweet gum, black gum, tupelo, and yellow poplar.

In the mud swamps along the larger streams there are, besides cypress and gums, ash, overcup oak, cottonwood, sycamore, and hackberry. Mixed with the other swamps, but covering less area and occurring only on sandy or peaty soil, are white cedar swamps, or "juniper bays," as they are usually called. The tree growth in these is largely and often entirely juniper or white cedar (*Chamaecyparis spheroidea* Spach) and white bay (*Magnolia glauca* L.). In the extreme eastern part of this section, in the immediate vicinity of the seacoast, there is a characteristic arborescent flora of red cedars and live oaks, while along its southern limits the palmetto and American olive (*Olea americana* L.) give it a semitropical aspect. On the other hand, as the clay and loam of the hill country is neared, the oaks and hickories rapidly increase among the pines, making the transition to the hard-wood uplands.

Several well-marked soil types of peninsular Florida, with their native growth, are thus described by Professor Whitney (A preliminary report on the soils of Florida, Bull. Div. Agric. Soils, U. S. Dept. Agr., vol. 13, pp. 8, 9, 1898):

There is a marked difference in the character of the native vegetation on the different types of soil in the State. The hammock land, considered the most valuable for most purposes, has a more or less heavy growth of white oak, live oak, water oak, bay, hickory, magnolia, and dogwood, so dense at times as to form a veritable jungle. The white oak is found only on the very best hammock lands, while the red oak and the long-leaf pine grow together on what is called the mixed lands. The high pine land and the pine flats, as the names imply, contain a monotonous growth of long-leaf or spruce pine, the character of the land having a great influence upon the forest growth.

There is, as a rule, a more or less marked difference in the appearance of the soils of these different types of land, but notwithstanding the very great difference in the character of the vegetation on the hammock and pine land soil no appreciable difference has yet been found, either from a chemical analysis or from an examination of the physical texture of the soils. * * *

The second quality of high pine land covers vast areas in the peninsula. It is a very light, rather coarse, sandy soil, less coherent than the hammock or first quality of pine land. Still the roads through it are good. The characteristic growth is the long-leaf pine. The trees are sparsely set and often of quite large size. There is very little undergrowth, and a wagon or carriage can be driven through the forest in almost any direction. There is generally a good growth of grass, and these lands are very extensively used for grazing.

* * * These second quality high pine lands form the principal truck areas at Gainesville, Orlando, Winterhaven, Grand Island, and Bartow. The country is generally rolling, with differences of elevation of from 25 to 50 feet. The whole elevation of the lake region, which is used for truck growing, is from 100 to 200 feet above sea level. The soil is a coarse white or yellow sand, underlaid by a coarse, sandy subsoil. It looks like a barren sea sand or a coarse, sharp, building sand; but that it is very productive is shown by the large and vigorous growth of pines, the luxuriant growth of grass, the great quantity of truck crops which can be produced during the season, and the enormous growth of beggar weed which takes possession of the land after the crops are removed. * * *

As already explained, the hammock lands are characterized by a native growth of hardwood trees, principally of oak, hickory, magnolia, dogwood, and the cabbage palmetto. There are quite a number of grades of hammock land, distinguished by the kind and density of the growth as well as by the character of the soil. There are light and heavy hammocks, so named from the density of the growth rather than from any appreciable difference in the character of the soil. The low, flat hammock, the high hammock, the heavy clay hammock, and the marl hammock, the various grades differing somewhat in the kind and relative proportion of the native trees. * * *

The great Etonia scrub formation was examined at Altoona. It is an impressive sight to stand at the border line between the scrub and the high pine land and notice the difference in the character of the vegetation. The high-land pine is open, the trees are large and vigorous, and the ground is covered with a crop of grass, which gives very good grazing for cattle. The vegetation is quick and generous, and the most tender plants will grow luxuriantly if properly attended to. These conditions stop abruptly at the edge of the scrub. The boundary between the high pine land and the scrub can be located without trouble within a few feet. * * * In the scrub there is a dense growth of scrub oaks and low bushes and plants, all having thick leaves protected to the utmost from loss of water by evaporation by the property that desert plants have of turning the leaves up edgeways to the sun to expose as little surface as possible to the direct rays. No grass is found, and only the most hardy desert plants grow. When pines grow, it is the dwarf spruce pine and not the long-leaf pine, while on the other hand the spruce pine is not found across the border in the high pine lands proper. The full-grown scrub vegetation reaches about the height of a man's head. * * * This scrub growth stretches out at this place in an unbroken line for 10 or 15 miles to the northward, and the whole country presents a most desolate appearance.

ANATOMICAL NOTES.

In the following pages are presented brief descriptions of the anatomy of some of the plants of the Dismal Swamp region which are most interesting from an ecological point of view. The leaf alone is described in most cases, that being the organ from whose structure conclusions can usually most readily be drawn as to the interaction of the organism and its environment, especially in matters of soil and climate. As a rule only the epharmonic characters—in other words, those by which the plant adapts itself to the physical conditions of its environment—so far as they have been determined, are here discussed. Most of these having already been mentioned collectively in describing adaptations to environment in the several plant formations, the species are here arranged in their systematic order, for convenience of comparison. The following is a synopsis of the species of each formation which are described below:

I. Maritime formations.[1]

A. Salt Marsh formation: Oxycoccus macrocarpus.

B. Sand Strand formation: Smilax bona-nox, Helianthemum canadense, Hudsonia tomentosa, Lechea maritima, *Gelsemium sempervirens*,[2] Galium hispidulum. *Lonicera sempervirens.*

II. Inland formations.

A. Dry Land formations.

1. Forest formations.

(*a*) Mixed Forest: Asarum virginicum, *Persea pubescens*, *Liquidambar styraciflua*, *Malus angustifolia*, *Ilex glabra*, Batodendron (Vaccinium) arboreum, Symplocos tinctoria, Styrax grandifolia, *Gelsemium sempervirens*, *Lonicera sempervirens.*

2. Cleared Land formations (noncultural).

(*b*) Shrubby: *Rosa carolina.*

(*c*) Herbaceous: Ascyrum stans, Hypericum pilosum, H. virgatum, Senecio tomentosus.

B. Fresh-water formations.

1. Palustrine.

(*a*) Forest: Smilax laurifolia, S. walteri, Phoradendron flavescens, Magnolia glauca, *Persea pubescens*, *Liquidambar styraciflua*, Itea virginica, Decumaria barbara, *Rosa carolina*, *Malus angustifolia*, *Ilex glabra*, I. lucida, Acer rubrum, Berchemia scandens, Nyssa aquatica, Leucothoë axillaris, L. racemosa, Pieris nitida, Xolisma foliosiflora, Kalmia angustifolia, Chionanthus virginica, *Gelsemium sempervirens*, *Lonicera sempervirens.*

(*b*) Open Marsh.

Low Marsh formation: Pluchea foetida.

SMILAX BONA-NOX L.

Sand Strand formation (innermost dunes).

Leaf thickish, evergreen, bifacial.

Epidermis: Ventral, cell walls thickish, the radial strongly undulate; cuticle nearly smooth. *Dorsal*, cuticle delicately wrinkled. Stomata numerous, level with the surface, each bordered by a pair of irregularly crescent-shaped subsidiary cells, the inner walls of the guard cells strongly thickened. Hairs none.

Palisade in one layer of short, wide cells. Pneumatic tissue rather compact.

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[1] The following maritime species which occur in the Dismal Swamp region were described by the author, as to their leaf anatomy, in Contr. U. S. Nat. Herb., vol. 5, pp. 285 to 312 (1900):

Sand Strand.—Panicum amarum Ell., Spartina patens (Ait.) Muhl., Uniola paniculata L., Myrica carolinensis Mill., M. cerifera L., Quercus virginiana Mill., Q. laurifolia Michx., Zanthoxylum clava-herculis L., Oenothera humifusa Nutt., Physalis viscosa L., Iva imbricata Walt.

Salt Marsh.—Spartina stricta (Ait.) Roth, Juncus roemerianus Scheele, Kosteletzkya virginica L., Monniera monniera (L.) Britton, Solidago sempervirens L., Aster tenuifolius L., Iva frutescens L., Borrichia frutescens (L.) DC.

[2] The names of species which normally occur in more than one formation are printed in *italics.*

Hypodermal collenchymatic tissue beneath the larger veins.

Stereome surrounding the mestome bundles, especially strong above and below them.

SMILAX LAURIFOLIA L.

Hygrophile Forest formation.

Leaf thick, evergreen, strongly bifacial, markedly xerophytic in structure (fig. 86).

Epidermis: Ventral, cell walls thickish, the radial strongly undulate; cuticle thick, finely wrinkled, yellow, sharply differentiated from the whitish, highly refractive outer walls of the epidermis cells. ***Dorsal,*** radial walls not undulate; cuticle thicker than on the ventral surface, nearly equaling the height of the lumina of the epidermis cells, strongly wrinkled, with a few broad, blunt ridges to each cell, otherwise as on the ventral surface. Stomata only on the dorsal surface, lying at right angles to the leaf's axis, deeply sunken (below the cuticle). Hairs none.

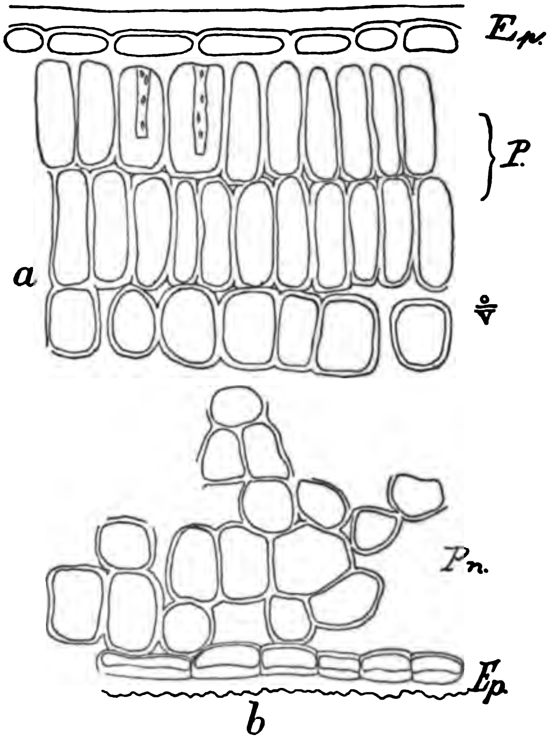

FIG. 86.—*Smilax laurifolia*, leaf in cross section. *a*, Ventral face; *b*, dorsal face. **Magnified 380 times.**

Palisade in two dense layers, the cells wide, with thick, pitted walls; then several layers of short-celled pneumatic tissue, with rather large intercellular spaces; and finally, beneath the dorsal epidermis, two rather compact layers of short cells.

Hypodermal collenchymatic tissue beneath the midvein, palisade not interrupted above it.

Stereome massively developed around the mestome bundles, completely surrounding them, but especially strong above and below them, very thick-walled.

SMILAX WALTERI Pursh.

Hygrophile Forest formation.

Leaf not thick, deciduous, approximately isolateral.

Epidermis: Cells containing much chlorophyll (especially those of the ventral surface), walls—especially the outer—thickish, the radial walls somewhat undulate on the ventral face, not undulate on the dorsal. Stomata few on the ventral face, numerous on the dorsal, about level with the surface, lying in all directions, each bordered by three to four undifferentiated epidermis cells. Hairs, none.

Mesophyll homogeneous through the leaf; palisade none, but intercellular spaces rather larger on the dorsal side.

Smaller *mestome bundles* entirely surrounded by rather thin-walled stereome.

PHORADENDRON FLAVESCENS (Pursh) Nutt.

Hygrophile Forest formation.

Leaf isolateral, thick, leathery, glabrous; veins, even the midvein, embedded in the mesophyll.

Epidermis: Cell walls straight, thick; cuticle thick, smooth. Stomata on both faces, lying in all directions, each bordered by a pair of subsidiary cells which are larger than the guard cells. Hairs none.

Mesophyll perfectly homogeneous, compact, in about ten layers of nearly isodiametric cells without intercellular spaces.

Groups of *stereome* adjoin the mestome bundles on both the hadrome and the leptome sides.

ASARUM VIRGINICUM L.

Forest (nonhygrophile) formation.

Leaf thickish, bifacial, smooth, punctate with semitransparent points.

Epidermis: Ventral, cells rather large in all dimensions, radial walls undulate;[1] the cuticle delicately wrinkled, thick, smooth, except on the leaf margins. *Dorsal*, cells smaller, lower, radial walls thicker and less undulate, the walls collenchymatically thickened beneath the midvein. Stomata confined to the dorsal surface, rather large, level with the surface, lying in all directions, each bordered by four to six ordinary epidermis cells. Rounded secretion cells numerous (one to every four stomata).[1] Hairs confined to the impressed veins of the upper surface and to the margins of the petiole, scattered, short, conical, blunt-pointed, four or five celled.

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[1] Solereder states that the cells of the epidermis on both faces have pitted walls (Engler's Bot. Jahrb., vol. 10, p. 427).

Palisade in two layers of short, broad cells, the inner less compact.[2] Pneumatic tissue from five to six layers, very open, with large air spaces.

Hypodermal collenchyma in several layers beneath the midvein and in the margins.

Stereome none.

Small groups of colorless parenchyma with small, thickish-walled cells occur above and below the mestome of the larger veins.

MAGNOLIA VIRGINIANA L.

Abundant in the Hygrophile Forest formation.

Leaf coriaceous, semipersistent (deciduous farther north, more persistent farther south), bifacial, dark green above, very glaucous beneath, densely pubescent when young, veins numerous, reticulated, prominent on the lower surface.

Epidermis: Ventral, cells low, considerably greater in the dimension parallel to than at right angles to the leaf surface, their walls straight or but slightly undulate; cuticle somewhat thickened. *Dorsal*, cuticle coated with granular wax. Stomata none on the ventral surface, lying in all directions on the dorsal surface, slightly sunken, each accompanied by two subsidiary cells.[3] Hairs numerous on the young leaves, more or less persistent along the veins, especially beneath, long, slender, sharp-pointed, with smooth cuticle, bicellular, the terminal cell much the longer.[4]

Hypoderm present on the ventral face above the large veins, its cells tabular, considerably larger than those of the epidermis, their walls rather thick.[5]

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[1] The presence of secretion cells in the epidermis is characteristic of most Aristolochiaceae (Solereder, loc. cit., p. 414; see also below, p. 506, foot note 4). In some species the walls of the secretion cells are suberized (Solereder, loc. cit., p. 417). In all Aristolochiaceae examined by Solereder the secretion was found to contain ethereal oil, although otherwise differing somewhat in different species (loc. cit., p. 419). In *A. virginicum* the secretion cells, found only in the lower epidermis, are of two kinds—large spherical or ellipsoidal cells 0.015 to 0.06 mm. in diameter, and smaller cells hardly distinguishable in size and shape from the ordinary epidermis cells (Solereder, loc. cit., pp. 423–424).

[2] Solereder describes *Asarum virginicum* as having three layers of palisade. The number probably varies. Even with the aid of the polarizer he failed to detect in the mesophyll crystals such as are abundant in *A. arifolium* and other species (loc. cit., pp. 423–424).

[3] A character of the Magnoliaceae. See Vesque in Nouv. Archiv. Mus., sér. 2, vol. 4, pp. 31, 35.

[4] Although the disproportion is less than in the hair of the *M. conspicua* figured by Vesque. (Loc. cit., *t. 2, f. 34*.)

[5] Lalanne (Feuilles persistantes, p. 79) describes a similar hypoderm occurring in the leaves of *M. grandiflora*, but apparently not confined to the neighborhood of the larger veins.

Palisade in two layers, the cells rather low. Pneumatic tissue only moderately open. Oil reservoirs numerous in the mesophyll.

Collenchymatic tissue strongly developed above the large veins, especially the midvein; less strongly developed beneath them.

Mestome bundle of the large veins arranged in a more or less perfect cylinder.

Stereome completely surrounding the midvein, especially strong beneath it, where it is separated from the collenchymatic tissue by a few layers of thin-walled colorless parenchyma. Narrow plates of stereome support the smaller veins, extending through the entire thickness of the leaf.[1] Stereome is also rather strongly developed in the leaf margins.

PERSEA PUBESCENS (Pursh) Sargent.

Mixed and Hygrophile Forest formations.

Leaves thick, more or less persistent, bifacial, dark green and somewhat shining above, somewhat glaucous and, especially when young, short-pubescent beneath. Structure in many respects similar to that of *Magnolia glauca.*

Epidermis: Ventral, cells tabular, the cuticle considerably thickened, the radial walls undulate. *Dorsal,* cell walls thinner, cuticle covered with a granular coating of wax, radial walls not undulate. Stomata confined to the dorsal surface, exceedingly numerous,[2] small, lying in all directions, level with the surface, each bordered by usually five unmodified epidermis cells. Hairs confined to the dorsal surface in older leaves, chiefly along the veins, long, sharp-pointed, with thick cuticle, unicellular.

Palisade in two layers, the outer more compact, interrupted over the veins by stereome. Pneumatic tissue lacunous.

Oil reservoirs in the chlorenchyma, large, spheroidal.

Larger *veins* strengthened above and below the mestome by massive groups of thick-walled stereome. Smaller veins supported by thin plates of thin-walled stereome.

Several layers of rather thick-walled colorless parenchyma separate the stereome supporters beneath the veins from the epidermis.

As would be expected, this species, which grows where air and soil contain abundant moisture at almost all seasons, exhibits a much less pronounced xerophytic structure than is found in others of the Lauraceae whose leaves are longer-lived and are adapted to a drier climate and soil. *Laurus nobilis*, for example, has an extremely compact palisade tissue of very long and narrow cells, and its stomata are placed at the bottom of cavities of which the external orifice is very small.[3]

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[1] In *M. tripetala* (*M. umbrella*) chlorenchyma occurs above and below the stereome supporters of the small veins, although that species has a leaf considerably thinner than that of *M. virginiana.* (Vesque, Nouv. Archiv. Mus., sér. 2, vol. 4, p. 37.)

[2] Lalanne (Feuilles persistantes, p. 82) finds the presence of a very large number of stomata on the under surface to be characteristic of leaves which are coriaceous, even when not "evergreen."

[3] Lalanne, op. cit., pp. 66 to 68.

LIQUIDAMBAR STYRACIFLUA L.

Occurs abundantly in the Mixed and the Hygrophile Forest formations.

Leaf bifacial.

Epidermis: Cells, especially those of the dorsal face, rather small, much broader than high, radial walls undulate; cuticle thin. Stomata none on the ventral face, numerous on the dorsal face, lying in all directions, level with the surface, each bordered by a pair of irregularly crescent-shaped subsidiary cells which are smaller than the other epidermis cells. Hairs in densely matted tufts in the axils of the principal veins at the base of the under surface of the blade, usually disappearing later on, long, flexuous, pointed, unicellular, with thick, smooth cuticle.[1]

Palisade in two layers, cells of the inner layer short. Pneumatic tissue moderately open. Large resin cavities in the mesophyll.[2]

Hypodermal collenchyma strongly developed above and especially beneath the principal veins, six to eight layers in old leaves.

Stereome forming an almost continuous thin sheath about the concentrically arranged mestome bundles of the large veins; in younger leaves often limited to a few thin-walled cells above the mestome group or altogether wanting.

A large resin canal occupies the center of the mestome group of the large veins.[3]

ITEA VIRGINICA L.

Hygrophile Forest formation.

Leaf rather thin, bifacial, midvein very prominent beneath.

Epidermis: Ventral, cells large, their walls straight or nearly so, thickish; cuticle smooth, thick, strongly thickened in the leaf margins, where it constitutes the only strengthening tissue. *Dorsal*, cell walls thinner, the radial strongly undulate. Stomata confined to the lower surface, small, nearly orbicular, lying in all directions, level with the surface,[4] each bordered by four or five ordinary epidermis cells. Hairs on the upper surface along the larger veins and on the leaf margins, few, short, pointed, thick-walled, prickle-like, unicellular, with smooth cuticle.[5]

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[1] According to Reinsch (Engler's Bot. Jarhb., vol. 11, p. 354) there are *no* hairs on the leaf of Liquidambar.

[2] Liquidambar and Altingia are among the genera of Hamamelidaceae which are distinguished from Hamamelis and other genera by the absence of sclerotic idioblasts (Spicularzellen) in the mesophyll of their leaves. (Reinsch, loc. cit., 363; Thouvenin, Ann. Sc. Nat. Bot., sér. 7, vol. 12, p. 135.)

[3] The presence of this duct is characteristic of Liquidambar and Altingia. (Reinsch, loc. cit., p. 368; Thouvenin, loc. cit., pp. 140, 141.)

[4] My observation on this point does not agree with Thouvenin's, who states (loc. cit., p. 123) that in Itea the guard cells are always lower than the other epidermis cells.

[5] Smooth according to Thouvenin, loc cit., pp. 118, 125.

Palisade in two layers, the cells short, especially those of the second layer, which is not sharply differentiated from the upper layers of the quite compact pneumatic tissue. Clusters of crystals of calcium oxalate in the palisade.[1]

Collenchymatic hypoderm in one layer beneath the midvein.

Stereome in a large group of very thick-walled cells below and adjoining the leptome of the midvein, separated from the hypodermal collenchyma by rather thick-walled, colorless parenchyma; also a smaller group of thinner-walled stereome on the hadrome side of the bundle, separated from the ventral epidermis by parenchyma like that below. All but the largest veins embedded in the mesophyll.[2]

DECUMARIA BARBARA L.

Hygrophile Forest formation, climbing high.

Leaf thin, bifacial.

Epidermis: Ventral, cells large, thin-walled, the radial walls not or but slightly undulate; cuticle but slightly thickened. *Dorsal*, cells smaller, their radial walls strongly undulate. Stomata confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four or five ordinary epidermis cells. Hairs only on the lower surface, especially along the veins, long, pointed, with rather thick, granular[3] cuticle, unicellular, each surrounded by several small radially arranged foot cells.[4]

Palisade in one layer. Pneumatic tissue open. Large cells, extended at right angles to the surface and containing raphides, in the palisade.

Hypodermal collenchyma above and especially below the larger veins (seven or eight layers below the midvein).[5]

ROSA CAROLINA L.

Cleared land (noncultural), Shrubby, and Hygrophile Forest formations.

Leaves thin, bifacial, more or less glaucous beneath, the veins impressed above, prominent beneath.

Epidermis: Cells high on the ventral surface, lower and smaller on the dorsal, the walls thin (even the outer only slightly thickened), radial not undulate. Stomata confined to the dorsal surface, lying in all directions, slightly prominent, each bordered by five to eight (mostly six) undifferentiated epidermis cells. Hairs along the veins, slender, flexuous, pointed, with very thick, smooth cuticle, unicellular, each bordered by several small radially arranged foot cells.

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[1] Crystals of calcium oxalate aggregated into "macles" in the pneumatic tissue and in the parenchyma of the nerves; also in the palisade, where they occupy cells that are "a little higher than the neighboring ones and almost spherical." (Thouvenin, loc. cit., 125.)

[2] Smaller veins embedded in the mesophyll, their strengthening tissue not "durchgehend" (going through to the epidermis). (Holle in Bot. Centralbl., vol. 53, p. 211, 1893.)

[3] Incrusted with $CaCO_3$. (Holle, Bot. Centralbl., vol. 53, p. 166, 1893.)

[4] Exactly like the hairs on the leaf of *Philadelphus billardieri* as figured by Solereder, Syst. Anat., p. 358, *f. 8 A.*

[5] Most of the cells of the outermost layer of the hypoderm and some in the succeeding layers contain tannin, as do the palisade cells and many of those of the pneumatic tissue, according to Thouvenin, Ann. Sc. Nat. Bot., sér. 7, vol. 12, p.

Hypodermal collenchyma strongly developed above and below the larger veins.

MALUS ANGUSTIFOLIA (Ait.) Michx.

(*Pyrus angustifolia* Ait.)

Hygrophile and Mixed Forest formations.

Leaf thin, bifacial.

Epidermis: Cells alike on both surfaces, radial cell walls not undulate; cuticle considerably thickened, strongly wrinkled. Stomata confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four or five ordinary epidermis cells. Hairs none.

Palisade in two layers of rather low cells. Pneumatic tissue open, with large intercellular spaces.

Hypodermal collenchyma strongly developed above the large veins and much more so below them, thick-walled.

ILEX GLABRA (L.) A. Gray.

Mixed and Hygrophile Forest formations.

Leaf thick, persistent, bifacial.

Epidermis: Ventral, cells small, almost isodiametric, radial walls slightly undulate; cuticle much thickened. *Dorsal*, radial cell walls not undulate; cuticle and cellulose layer of the outer walls beneath the midvein nearly twice as thick as elsewhere and about equaling the lumen of the cells in height. Stomata confined to the dorsal surface, bordered by four or five ordinary epidermis cells. Hairs on the upper surface only, scattered along the midvein (as in *I. opaca* and *I. vomitoria*, but less pointed and with thinner cuticle), erect, prickle-like, thick-walled, unicellular.[1]

Palisade compact, four-layered, the cells only slightly higher than wide, all but about one layer replaced by collenchymatic tissue above the midvein. Pneumatic tissue open, with large intercellular spaces.

Hypodermal collenchymatic tissue in about four layers beneath the midvein, with an equal number of layers beneath the thin stratum of chlorenchyma above the vein.

Stereome very thick-walled, in a large slightly curved group adjoining the leptome of the larger mestome bundles, in two or three small groups adjoining the hadrome.

---

[1] According to Solereder (Syst. Anat., p. 237) "hairs are rare in Ilicaceae." Trichomes of the type here described are known to him only on the petiole of *Ilex aquifolium* and the blade of *I. pseudothea*. For a description of similar hairs in *Ilex vomitoria* see Kearney, Contr. U. S. Nat. Herb., vol. 5, p. 296.

ILEX LUCIDA (Ait.) Torr. & Gr.

Hygrophile Forest formation.

Leaf thick, persistent, bifacial. The material examined was in an advanced stage of development.

Epidermis: Ventral, cells small, radial walls thick and porous, straight; cuticle massive, especially above and below the midvein, there about equaling, with the cellulose layer of the wall, the height of the lumina of the epidermis cells. *Dorsal*, cells as on ventral surface; cuticle thinner, except beneath the midvein, where it considerably exceeds the lumina of the epidermis cells in height. Stomata confined to the dorsal face, apparently less numerous than in *I. glabra*, lying in all directions, the whole stoma considerably larger than each of the five to seven bordering epidermis cells. Hairs, as in *I. glabra*, only on the ventral surface along the impressed larger veins (especially the midvein) having a massive, roughened cuticle and an almost obliterated lumen.

Palisade much as in *I. glabra*, three-layered, occupying about one-half the leaf's thickness, very compact, the cells about twice as high as they are wide. Pneumatic tissue less open, with smaller lacunes than in *I. glabra*.

Hypoderm (as in *I.opaca*) in a single layer above the midvein.[1]

Beneath the hypoderm occur about two layers of chlorenchyma with nearly isodiametric cells. On the dorsal surface beneath the midvein there are five or six layers of thick-walled collenchyma.

Stereome very thick-walled, in interrupted bands above and below the midvein, which is composed of several radially arranged mestome bundles; but only on the leptome side of the small veins, each of which consist of a single bundle.

Leaf margins containing neither stereome nor collenchyma, but strengthened by the great thickening of the cuticle.

ACER RUBRUM L., var.

Hygrophile Forest formation.

Leaf bifacial, dark green and somewhat shining above, white-glaucous beneath.

Epidermis: Ventral, cells with nonundulate radial walls. *Dorsal*, cells much smaller; cuticle covered with wax. Stomata confined to the dorsal surface, lying in all directions, very numerous, level with the surface, each bordered by five to seven undifferentiated epidermis cells. Hairs densely covering the dorsal surface of the young leaf, especially along the veins; long, weak, flexuous, blunt-pointed, thin-walled, unicellular.[1]

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[1] Not, as in *I. aquifolium*, occuring under the epidermis of the entire ventral surface. In that species the hypoderm is described by Lalanne (Feuilles persistantes. p. 55) as a second layer of epidermis. But Pfitzer (Pringsheim's Jahrb., vol. 8, p. 51), who studied its development, found it to be true hypoderm, originating from tissue beneath the epidermis. Its cell walls are moderately thickened collenchymatically.

Palisade in one layer, the cells high, forming more than one-half the thickness of the mesophyll. Pneumatic tissue with small lacunes.

Sacs containing a milky fluid occur in the pneumatic tissue[2] and in the leptome of the veins.

Veins prominent beneath, the larger reenforced above and below by strongly developed, hypodermal collenchymatic tissue. Mestome bundles surrounded by a sheath of stereome. Thin-walled, colorless parenchyma in a few layers beneath the larger veins, lying between the sterome and the collenchymatic tissue.

BERCHEMIA SCANDENS (Hill) Trelease.

Hygrophile Forest formation, climbing high.

Leaves ombrophobic, thin, bifacial, veins very prominent beneath, leaves not punctate.

Epidermis: Ventral, cells large, high (i. e., extended at right angles to the surface), the outer wall and the granular cuticle thickened, the other walls thin, not undulate. *Dorsal,* cells similar, but with thinner outer walls (except under the large veins). Stomata on the lower face only, lying in all directions, level with the surface, each bordered by usually four or five undifferentiated epidermis cells. Hairs none.

Palisade in a single layer, very compact. Pneumatic tissue rather open.

Subepidermal collenchyma in several very narrow layers above, and several wide layers beneath the larger veins.

Stereome rather thin-walled, weakly developed adjacent to the hadrome and leptome of the larger veins, that beneath the leptome separated from the subepidermal collenchyma by several layers of thin-walled, colorless parenchyma.

Mucilage in the cells of the epidermis[3] and in one or two layers of the colorless parenchyma beneath the mestome bundles of the midvein.

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[1] "Several-celled glandular hairs in all species [of Acer] except *A. distylum.*"—Solereder, Syst. Anat., p. 271. I did not detect them in *A. rubrum*, even on quite young leaves.

[2] Heretofore known to occur in the mesophyll of Acer only in *A. campestre.*—Solereder, Syst. Anat., p. 271.

[3] Volkens (Flora der Äegyptisch-Arabischen Wüste, p. 115) says of *Zizyphus spinacristi:* "A great part of its extraordinarily high epidermis cells is filled with cellulose slime."

Berchemia is one of the genera of Rhamnaceae in which there are no special mucilage reservoirs, such as occur in Rhamnus, Ceanothus, and other genera of this family, where they are found in the mesophyll, and in the primary cortex and pith of the stem. Guignard et Colin, Bull. Soc. Bot. de France, vol. 35, pp. 325–327.

Blenk (Flora, vol. 67, p. 356) states that he does not find mucilage in the epidermis cells of any Rhamnaceae which have crystals of calcium oxalate in the palisade.

ASCYRUM STANS Michx.

Cleared land (noncultural), Herbaceous formation, preferring rather moist soil.

Leaf nearly erect (when growing where it is exposed to strong light), bifacial.

Epidermis: Ventral, cells large, with rather thick walls, the radial ones not undulate. *Dorsal*, radial walls slightly undulate; cuticle bearing a coating of wax. Stomata on the dorsal surface only, lying in all directions, sunken, each bordered by three to five ordinary epidermis cells,[1] the guard cells with thick cuticle. Hairs none.

Palisade in one layer; then two layers of tissue, similar but not compact; then open pneumatic tissue with low cells. Secretion cavities in the mesophyll near the ventral surface.

Hypodermal collenchymatic tissue well developed above, and especially below the midvein.

HYPERICUM VIRGATUM LAM.

Cleared land (noncultural), Herbaceous formation, often with the preceding.

Leaf small, erect, and often somewhat appressed to the stem, isolateral.

Epidermis much alike on both surfaces, the cells comparatively very large, their radial walls slightly undulate on the ventral surface, more so on the dorsal; cuticle granular. Stomata on both faces, more numerous on the dorsal, mostly parallel to the veins, sunken, each bordered by three (rarely four) undifferentiated epidermis cells. Hairs none.

Palisade in one layer on each side of the leaf,[2] inclosing the thin, central stratum of nearly colorless pneumatic tissue. Large secretion cavities present in the mesophyll.

Hypodermal collenchymatic tissue above and below the midvein.

Stereome none.

HYPERICUM PILOSUM Walt.

Cleared land (noncultural), Herbaceous formation, growing in dry, sandy fields.

Leaf much like that of *H. virgatum* as to position, but densely pubescent, isolateral (fig. 87).

---

[1] Compare Vesque (Comptes Rendus, vol. 100, p. 1089), who says, "The Hypericums are characterized by stomata bordered by three epidermis cells."

[2] *H. virgatum* and *H. pilosum* (see below) are exceptional among Hypericaceae in the isolateral structure of their leaves. Solereder (Syst. Anat., p. 134) describes the mesophyll in this family as, "so far as is known, bifacially arranged." He further says (p. 135) that "stomata in the Hypericaceae are present only on the underside of the leaf."

Epidermis alike on both faces, the cells large, with strongly undulated radial walls; cuticle rather thick, granular. Stomata about equally numerous on both surfaces, lying in all directions, sunken, each bordered by three ordinary epidermis cells. Hairs rather thin-walled, tapering to a rounded apex, pluricellular, cells in a single row (sometimes as many as sixteen), each hair surrounded by several radially arranged foot cells.[1]

Palisade on each face, inclosing the thin central stratum of pneumatic tissue.

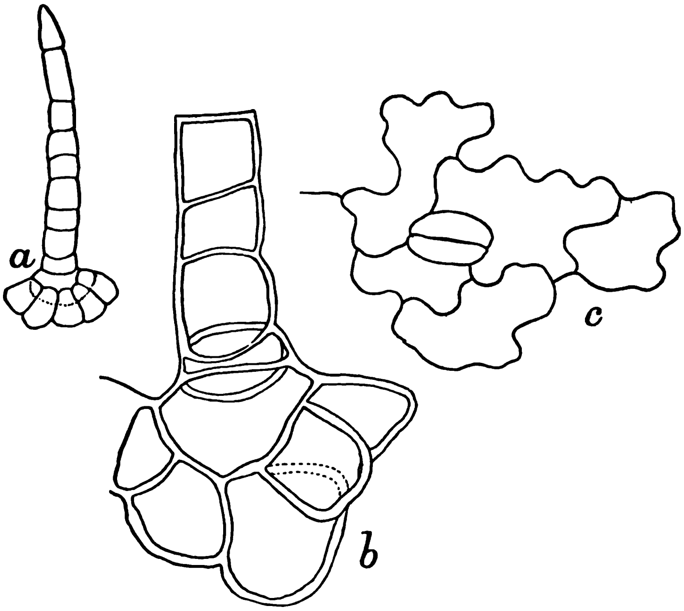

FIG. 87.—*Hypericum pilosum*, leaf. *a*, Hair from ventral face magnified 112 times; *b*, same magnified 480 times; *c*, portion of epidermis showing stoma, magnified 480 times.

Hypodermal collenchyma above and below the midvein, more strongly developed below.

Stereome none.

LECHEA MARITIMA Leggett.

Belongs to the Sand Strand formation, growing abundantly among the open dunes with *Hudsonia tomentosa*.

Leaf isolateral, pilose, with long hairs.

---

[1] Such multicellular, unbranched hairs have not been hitherto detected in Hypericaceae, so far as I can learn. Vesque (Comptes Rendus, vol. 100, p. 1089, 1885) found stellate hairs with a stalk consisting of a single row of cells in three genera of Vismieae—Vismia, Psorospermum, and Haronga. Solereder (Syst. Anat., p. 135) mentions only hairs of that type as occurring in Hypericaceae, nor does he mention the occurrence of any kind of hairs in the tribe Hypericeae.

Epidermis: Cells large, with thin, not undulate walls. Stomata few on the ventral surface, much more numerous on the dorsal, lying mostly parallel to the leaf's axis, each bordered by four or five undifferentiated epidermis cells. Hairs (fig. 88) on both surfaces, but much more numerous and with more warty cuticle on the dorsal face, long, rather stout, sharp-pointed, with very thick cuticle, contracted shortly above the base, seemingly bicellular, the basal portion separated from the rest of the lumen by a membrane which is convex toward the apex of the hair, the lower portion about one-half as long as the upper, base of hair bordered by several radially arranged foot cells. Many of the epidermis cells on both faces are greatly enlarged, and probably serve for storage of water.[1]

Palisade in one layer on each face of the leaf. Pneumatic tissue central.

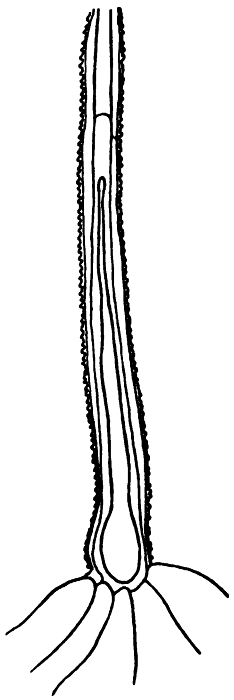

Fig. 88.—*Lechea maritima.* Falsely bicellular hair from leaf. Magnified 360 times.

Hairs similar to those just described form the dense covering of the leaves of *Hudsonia tomentosa*, but in that species they are more slender and have a smooth cuticle. They also occur in *Helianthum canadense* (which see). Solereder[2] describes hairs of this character in *Lechea major* and *Hudsonia ericoides*, and figures one from the leaf of *Cistus creticus*, in which, however, the basal portion of the lumen cut off by the dividing membrane is proportionately much shorter than in *Lechea maritima*. He found that Eau de Javelle stains the dividing membrane yellow, while the walls of the original cell remain white. He states that this type of hair is peculiar to Cistaceae and Combretaceae.

A very interesting description of these falsely bicellular hairs in Combretaceae is given by Heiden,[3] who found them so characteristic in that family that he terms them "Combretaceae hairs." Thiloa is apparently the only genus of Combretaceae in which they are even rare. Heiden's description is as follows:

"But what is characteristic of these hairs is the circumstance that the mostly somewhat bulbous-swollen base is separated from the principal part of the hair, which is filiform, by a layer of cellulose which projects more or less convexly or conically toward the latter. So in many cases it seems as if the Combretaceae hairs in question are not one-celled, but rather two-celled.

"That these apparently two-celled hairs are not to be regarded as two-celled is very clearly shown by their development.

"The first stage of development here considered (see plate fig. 1a) consists of an already pretty thick-walled, long-pointed, one-celled hair, whose lumen widens out in the lower part, while in the upper part it is almost filiform. The entire lumen of the one-celled hair is filled with protoplasm, which contains a pretty large cell nucleus in the base of the hair. In a hair which has developed somewhat farther one finds that the wall of the hair has become somewhat thicker, and that the protoplasm which originally filled both the base of the cell and the channel of the hair has altogether withdrawn to the base of the cell and has completely left the channel; the protoplasm now fills only the base of the cell and deposits on the side which faces the channel of the hair a membrane which in the particular plant in which its development was studied increases considerably in thickness. In other species, as will be shown, this membrane, which is thrown off by the protoplasm (on the side) facing the apex of the hair, remains relatively thin.

---

[1] Solereder (Syst. Anat., p. 91) mentions similarly specialized epidermis cells in *L. minor* L. (*Lechea novae-cesareae* Aust.).

[2] Syst. Anat., p. 91. *f. 21 A.*

[3] Bot. Centralbl., vol. 55, pp. 358, 359, and vol. 56, p. 64, *f. 1*, 1893.

"No nuclear division, therefore, occurs in this hair cell; in these Combretaceous hairs, as has already been said, we have to do with true one-celled trichomes."

HELIANTHEMUM CANADENSE (L.) Michx.

In open pine woods near the strand.

Leaf bifacial, pubescent, especially beneath.

Epidermis: Cells with thin walls, the radial somewhat undulate. Hairs on both surfaces of three types: (1) Pluricellular, scale-like, stellate hairs with 3 to 8 slender, sharp-pointed arms that are parallel to the leaf surface, each hair bordered by several radially arranged foot cells; (2) long, stout, very thick-walled falsely bicellular hairs of the peculiar cistaceous type described under *Lechea maritima*, and (3) rather few multicellular, glandular hairs. Stomata only on the dorsal surface, numerous, mostly parallel to the longer axis of the leaf, level with the surface.

Palisade compact; pneumatic tissue rather open.

Hypodermal collenchyma strongly developed above and below the larger veins.

NYSSA AQUATICA L.

(*Nyssa uniflora* Wang.)

Hygrophile Forest formation.

Leaf large, thin, bifacial, pubescent beneath, especially when young.

Epidermis: Ventral cells containing mucilage, radial walls not undulate; cuticle striate. *Dorsal* cells much smaller,[1] radial walls slightly undulate. Stomata on the dorsal surface only, lying in all directions, level with the surface, each bordered by 4 or 5 undifferentiated epidermis cells. Hairs, confined to the dorsal surface in mature leaves, of two kinds: (1) Abundant along the veins, long, pointed, with thick, warty cuticle, unicellular, and (2) much fewer, small, thin-walled, clavate, unicellular, probably glandular.

Palisade in one layer. Pneumatic tissue rather open. Sclerotic idioblasts extending from the ventral almost to the dorsal epidermis.

---

[1] The outer walls of the cells of the dorsal epidermis are described as "papillosely convex" by Sertorius (Bull. de l'Herb. Boiss., vol. 1, p. 633).

Hypodermal collenchymatic tissue in a few layers above and below the larger veins.

Stereome in a thin ring almost or quite surrounding the larger veins, that on the leptome side separated from the collenchymatic tissue by several layers of colorless parenchyma.

LEUCOTHOË AXILLARIS (Lam.) D. Don.[1]

Hygrophile Forest formation.

Leaf thick, evergreen, bifacial, dark and shining above, pale beneath.

Epidermis: Cells alike on both faces, large; their radial walls slightly undulate; outer wall and cuticle strongly thickened; cuticle slightly wrinkled. Stomata (fig. 89) large, mostly parallel to the veins but, with many exceptions, slightly prominent; guard cells with thick, strongly wrinkled cuticle; each stoma bordered by usually four epidermal cells, two of which are parallel to and in all respects resemble the guard cells. Hairs scattered along the impressed midvein on the upper surface of the leaf, nearly erect, very thick-walled, sharp-pointed, unicellular (much as in species of Ilex).

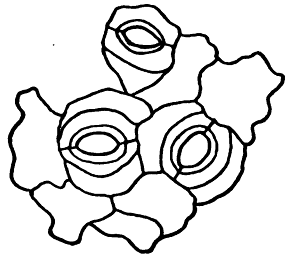

FIG. 89.—*Leucothoë axillaris.* Lower surface of leaf showing stomata. Magnified 480 times.

Palisade two-layered, compact. Pneumatic tissue very open, with numerous, rather large, intercellular spaces. Scattered cells of the mesophyll contain sharp-pointed masses of calcium oxalate crystals.

Hypodermal collenchymatic tissue in two or three layers above and beneath the larger veins—that above adjoining stereome, that beneath separated from the mestomatic stereome by very open pneumatic tissue, which contains crystals.

Stereome in two strong groups adjoining, respectively, the hadrome and the leptome of the larger veins; also in strong groups in the leaf margins, very thick-walled (lumen almost obliterated), interrupted by numerous thin-walled tannin cells.[1]

---

[1] Vesque (Ann. Sc. Nat. Bot., sér. 7, vol. 1, p. 233) observes that "apart from some rare species the Ericaceae are eminently xerophile." The truth of this statement is borne out by the structure of those species which occur in the Dismal Swamp, where, if anywhere, hygrophile species would be sought.

Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, p. 185 (1890). *L. axillaris* and *L. catesbaei* are there characterized and the glandular hairs of both species are figured (*t. 3, f. 10*). Although Niedenzu says "the glandular hairs persist on the old leaf," I could find none on my material of either species. Nor did my specimens of *L. axillaris* show more than two layers of palisade, while Niedenzu gives 3 or 4 as their number. He found 4 to 6 subsidiary cells about the stomata in this group of species.

LEUCOTHOË RACEMOSA (L.) A. Gray.

Hygrophile Forest formation, usually in sunny places.

Leaf thin, not persistent, bifacial.

Epidermis: Cells smaller than in *L. axillaris* and *L. catesbaei*, with thinner, smooth cuticle and more undulate radial walls. Stomata only on the dorsal surface, much smaller than in the other species of Leucothoë, mostly lying at right angles to the veins but with some exceptions, slightly prominent, their cuticle thin and smooth, each bordered by usually four epidermis cells, of which two are parallel to the guard cells (subsidiary),[2] but not otherwise differentiated. Pluricellular, glandular hairs along the veins on the dorsal surface.

Palisade in two layers, the outer compact, the inner more open, with shorter (lower) cells. Pneumatic tissue less open than in the persistent-leaved species.

Hypodermal collenchymatic tissue in about two layers above and one beneath the midvein, that above adjoining the stereome supporters of the mestome bundles, that below separated from it by several layers of colorless parenchyma (which, like the corresponding tissue in *L. axillaris*, contains crystals).

Stereome about the mestome bundles, as in the other two species, but less strongly developed; none in the leaf margins.

Differs from the evergreen species, especially in its thinner leaf, with less development of cuticle, palisade, mechanical tissue, and wood.

PIERIS NITIDA (Bartr.) Benth. & Hook.[3]

Hygrophile Forest formation, chiefly in sunny places.

Leaf thick, evergreen, bifacial, shining above.

---

[1] LEUCOTHOË CATESBAEI (Walt.) A. Gray.

A remarkably similar plant, occurring along streams in the Allegheny Mountains. (Material examined in cultivation at Brookland, D. C.)

Leaf much as in *L. axillaris*.

Stomata somewhat more irregular in position. Palisade more compact, in three layers (the innermost more open). Collenchymatic tissue with thinner, less lignified walls. Hadrome of midvein only about one-half as great in quantity. Midvein much more deeply impressed.

These differences, with the exception of the position of the stomata, are possibly due in part to the fact that the leaves of *catesbaei* examined were younger than those of *axillaris*, although the differences in age must have been but small.

[2] Niedenzu (Engler's Bot. Jahrb., vol. 11, p. 185 (1890)) mentions the occurrence of usually four subsidiary cells adjoining the guard cells of the stomata in *Leucothoë racemosa* and *L. recurva*.

[3] Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, pp. 180-182 (1890). The glandular hairs of *P. floribunda* (Pursh) Hook. f. are figured, *t. 3, f. 8;* and the stomata of *P. japonica* (Thunb.) Don, *t. 3, ff. 11, 12.*

Epidermis: Cells alike on both surfaces, rather small, the radial walls somewhat undulate, the tangential (especially the outer) greatly thickened; cuticle thick, delicately wrinkled. Stomata confined to the lower surface, large, lying in all directions, the ridges of entrance slightly prominent, the guard cells with greatly thickened cuticle, each bordered by usually five ordinary epidermis cells which they greatly exceed in size. Hairs scattered over the surface of the midvein on the dorsal side of the leaf, short, erect, conical, pointed, very thick-walled, unicellular; also scattered pluricellular glands on short pluricellular stalks.

Hypoderm continuous on the ventral side of the leaf, one-layered, its cells nearly iso-diametric, containing chlorophyll.

Palisade one-layered, very compact, the cells little higher than broad. Pneumatic tissue occupying most of the thickness of the leaf, very open, with large intercellular spaces, containing scattered crystal cells (calcium oxalate).

Mestome bundle of the midvein strongly compressed in the plane of the leaf.

Hypodermal collenchymatic tissue in one layer above and two or three below the midvein.

Stereome in a thin interrupted supporting band above and below the midvein, also (rather thin-walled) in the leaf margin.

XOLISMA FOLIOSIFLORA (Michx.) Small.[1]

Hygrophile Forest formation, usually in sunny places.

Leaf comparatively thin, probably deciduous, bifacial, somewhat shining above.

Epidermis: Ventral, radial cell-walls somewhat undulate, the outer and cuticle moderately thickened; cuticle strongly wrinkled. *Dorsal,* radial walls strongly undulate; the cuticle thinner and less wrinkled. Stomata only on the lower surface, lying in all directions, about level with the surface, each bordered by four to six undifferentiated epidermis cells. Hairs confined to the lower surface, scattered, somewhat elongated, pluricellular, glandular; also, along the midvein, there are blunt-pointed, unicellular hairs with thick granular wall.

Palisade in one compact layer of rather low cells. Pneumatic tissue open.

Hypodermal collenchymatic tissue in one or two layers above and two or three beneath the midvein.

Stereome rather thin-walled, forming an almost uninterrupted thin sheath around the larger mestome bundles.

---

[1] Compare Niedenzu's characters for the nearly related *Xolisma* (*Lyonia*) *ligustrina* in Engler's Bot. Jahrb., vol. 11, pp. 180, 181 (1890). That species is described as having two layers of palisade, the cells high and narrow. Its glandular hairs are figured in *t. 3, f. 9.* Vesque (Ann. de Sc. Nat. Bot., ser. 7, vol. 1, p. 235) describes *Lyonia paniculata* as having the palisade in two layers, and "the cells of both layers alike are six to eight times longer than wide."

KALMIA ANGUSTIFOLIA L.

Hygrophile Forest formation.

Leaf persistent, coriaceous, bifacial, dark green above, glaucous beneath.

Epidermis: Ventral, cells small, their radial walls somewhat undulate; cuticle greatly thickened. *Dorsal*, cells much smaller, their lumen in old leaves hardly wider than the thickness of the cuticle; cuticle bearing a deposit of wax. Stomata none on the ventral surface, numerous on the dorsal surface, small, lying in all directions, bordered by several undifferentiated cells of the epidermis, the guard cells not projecting.[1] Hairs of two types, the first short, straight, or curved, conical, pointed, unicellular, with very thick, smooth cuticle and lumen almost obliterated. These form a dense covering on the under surface of the young leaf, where many persist, while on the upper surface they soon become broken off, for the most part.[2] Second, much fewer and larger, long-stalked, capitate, multicellular, glandular hairs.

Palisade in two or three layers of high, narrow cells, only the outermost compact. Pneumatic tissue with numerous lacunes, its cells much like those of the palisade. Cells which contain rather large and unusually perfect masses of crystals ("Drusen" or "macles") of calcium oxalate are numerous in the mesophyll.

Hypodermal collenchymatic tissue in three layers above and below the midvein.

Stereome in a thin band of thick-walled cells adjoining the under side of the mestome bundle-group of the midvein. Also, in well-developed leaves, a small group of thinner-walled stereome adjoining the upper side of the vein. Finally, a small group of thin-walled stereome in the slightly incurved leaf margins.

BATODENDRON ARBOREUM (Marsh.) Nutt.[3]

(*Vaccinium arboreum* Marsh.)

Mixed Forest formation, growing in dry, open woods.

Leaf flat, horizontal, bifacial, veins rather prominent beneath.

Epidermis: Cells low and small, with thin, undulate radial walls, outer wall and cuticle considerably thickened; cuticle wrinkled, especially opposite the larger veins; somewhat thinner on the dorsal surface except beneath the larger veins. Stomata large, confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four epidermal cells, of which two are subsidiary (parallel to the guard cells but not otherwise differentiated). Hairs only on the dorsal surface, scattered along the veins, long, pluricellular, glandular, with large heads.

---

[1] In many Rhododendroideae which have the under side of the leaf provided with a hairy covering, the guard cells are very prominent. Breitfeld in Engler, Bot. Jahrb., vol. 9, pp. 327–329.

[2] They are the "poils tecteurs unicellulés" of Vesque (Ann. Sc. Nat. Bot., sér. 7, vol. 1, p. 226), who distinguishes three types of hairs in Ericaceae. He remarks that those of Kalmia are noteworthy as being narrower than the epidermis cells from which they originate—a "particularité très caractéristique."

[3] Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, pp. 193, 195 (1890). The two subsidiary cells about the guard cells of the stomata are characteristic of the Vacciniaceae (loc. cit., p. 193).

Palisade in one compact layer, the cells high. Pneumatic tissue with rather small intercellular spaces.

Stereome rather strongly developed next both the hadrome and the leptome of the larger veins, interrupted by thin-walled tannin (?) cells.

Subepidermal, thick-walled colorless parenchyma between stereome and epidermis, very little above the veins, in considerable quantity below.

Hypodermal collenchymatic tissue in about two layers in the margins.

OXYCOCCUS MACROCARPUS (Ait.) Pers.

In brackish meadows.

Leaf small, thickish, persistent, bifacial, dark green above, glaucous beneath.

Epidermis: Ventral, cells small, radial walls strongly undulate, rather thin; cuticle moderately thickened. *Dorsal*, cells with less undulate walls;[1] cuticle covered with a finely roughened coating of wax. Stomata confined to the lower surface, very numerous, small, lying mostly parallel to the leaf axis but with many exceptions, level with the surface, each bordered by four epidermis cells, two of them subsidiary. Hairs none on the surface of the leaf; small multicellular, clavate glandular hairs sparsely scattered along the margins.

Palisade in one layer of short cells, which are little longer than wide. Pneumatic tissue open, with large lacunes. Tabular crystals, probably of calcium oxalate, in the mesophyll.

Hypodermal collenchymatic tissue in small quantity above and below the midvein.

Stereome in massive groups of very thick-walled cells above and below (adjoining) the mestome of the midvein, but only below the smaller veins, which are embedded in the mesophyll.

SYMPLOCOS TINCTORIA (L.) L.'Hér.

Mixed Forest formation, usually in low woods.

Leaf rather large, nearly horizontal, bifacial, rather thin, lateral veins prominent beneath.[2]

---

[1] This stronger undulation of the radial walls on the *upper* leaf surface appears somewhat anomalous.

[2] Solereder, Syst. Anat. der Dicot., p. 587, describes the lateral [illegible] *phylla* as embedded in the mesophyll.

Epidermis: Alike on both faces, cells containing chlorophyll, rather large, with thin, undulate radial walls and thickish wrinkled cuticle. Stomata confined to the dorsal surface, small, lying in all directions, level with the surface, each bordered by usually four epidermis cells, of which two are subsidiary (parallel to the guard cells but not otherwise differentiated). Hairs few on the ventral, numerous on the dorsal surface, soon deciduous, pointed, with rather thick, rough cuticle, pluricellular (the cells in a single row).

Palisade in a single layer, the cells high. Pneumatic tissue rather open.

Hypodermal collenchyma strongly developed above and below the midvein.

Stereome both above and below the veins (especially adjoining the leptome).

STYRAX GRANDIFOLIA Ait.

Mixed Forest formation, growing in low woods.

Leaf large, thin, bifacial, pubescent beneath.

Epidermis: Cells alike on both faces, the radial walls strongly undulate; cuticle delicately wrinkled. Stomata only on the dorsal face, small, comparatively few, lying in all directions, level with the surface, each bordered by four to seven undifferentiated epidermis cells. Hairs confined to the dorsal surface, more or less abundant, especially along the veins, long, sharp-pointed, thick-walled, unicellular.[1]

Mesophyll not well differentiated, two layers of compact but not elongated cells beneath the ventral epidermis, the rest open pneumatic tissue with large unicellular spaces.

Hypodermal collenchymatic tissue in small quantity above the large veins. True collenchyma in corresponding position below the veins.

Stereome none.

CHIONANTHUS VIRGINICA L.

Hygrophile Forest formation, inhabiting swampy woods along streams.

Leaf large, bifacial, green on both surfaces, becoming somewhat coriaceous, glabrous when mature, pubescent on both surfaces, but especially beneath, when young.

Epidermis: Ventral, cells small with thickish walls, the radial walls not undulate; cuticle strongly wrinkled. *Dorsal*, cells with straight or slightly undulate radial walls; cuticle with more numerous finer wrinkles. Stomata confined to the lower surface, very numerous, small, lying in all directions, level with the surface, each bordered with 5 or 6 ordinary epidermis cells. Hairs of two types, about equally numerous. First, long, sharp-pointed, with cuticle somewhat roughened, composed of 2 to 4 cells in one series. Second, multicellular, probably glandular, shield hairs, with a very short stalk which occupies slight depressions in the epidermis so that the flattened, disk-shaped head appears to rest on the surface; head composed of 6 to 18 wedge-shaped cells.[1]

---

[1] It does not appear that unicellular hairs have been previously noted in this family (cf. Solereder Syst. Anat., 587).

Palisade in one layer. Pneumatic tissue quite compact.

Larger veins prominent beneath, the mestome bundle or group of bundles (several bundles, inclosing pith, form the midvein), almost entirely surrounded by a narrow ring of rather thin-walled sterome, which is separated above and below from the finally massively developed hypodermal collenchyma by thin-walled, colorless parenchyma, which becomes collenchymatic in old leaves.

GELSEMIUM SEMPERVIRENS L.

In most different situations, from the Hygrophile Forest to the Sand Strand.

Leaves evergreen, thickish, shining above, horizontal, bifacial. (Leaves examined probably in their second season.)

Epidermis: Ventral, cells large and high, the cuticle and outer wall much thickened, the other walls thin, the radial not undulate. *Dorsal*, cells smaller, their walls thinner, and not or but slightly undulate. Stomata only on the dorsal surface, lying in all directions, somewhat prominent, the guard cells each accompanied by a parallel subsidiary cell, with occasionally a third parallel cell of similar form.[2] Hairs, none.

Palisade, cells low and comparatively wide, only the uppermost layer perfectly compact; the next two similar but with small intercellular spaces; then about two layers of open pneumatic tissue with nearly isodiametric cells; and finally a continuous layer of chlorenchyma adhering to the dorsal epidermis, easily separating from the pneumatic tissue, with its cells elongated in a direction parallel to the surface.

Hypodermal collenchyma in two layers beneath the midvein, thick-walled.

---

[1] Prillieux (Ann. Sc. Nat. Bot., sér. 4, vol. 5, p. 9, *t. 2*, *f. 14*) states that the number of cells is 12 and the diameter of the head is 55 micromillimeters. These figures can be taken as representing the average number and size, although the variation is considerable.

[2] The relation is comparable to that figured for stomata of Rubiaceae with three subsidiary cells (Solereder, Syst. Anat., p. 503, *f. 101, G*), except that in Gelsemium all the cells are of approximately equal size.

Stereome in a thin, wide group beneath the leptome and a small group above the hadrome of the midvein.

GALIUM HISPIDULUM Michx.

Sand Strand formation, inhabiting the innermost wooded dunes and the pine woods immediately behind them.

Leaf thickish, bifacial (fig. 90).

Epidermis nearly alike on both faces. Cells considerably elongated parallel to the length of the leaf; those of the ventral surface high, radial walls thickish (especially on the ventral surface), strongly undulate; cuticle strongly thickened, especially in the leaf margins, where it greatly exceeds the lumen, wrinkled, raised to a papilla in the center of the outer wall of each cell which is not extended into a hair.[1] Stomata few on the ventral surface, very numerous on the dorsal, lying in all directions, level with the surface, each bordered by two (occasionally four) parallel crescent-shaped subsidiary cells, one of which is usually larger,[2] these bordered by three to five (usually five) ordinary cells. Hairs on both surfaces stout, blunt-pointed, curved, unicellular, prickle-like, with a thick, granular cuticle.[3] Large cells containing resin scattered in the dorsal epidermis[4] (fig. 90, *c*).

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[1] "In *Bouvardia cordifolia* virtually every epidermis cell of the upper surface is raised into a small conical point furnished with radiating cuticular striae." Vesque. Ann. Sc. Nat. Bot., ser. 7, vol. 1, p. 192.

[2] "The stoma [in Rubiaceae] is always accompanied by two lateral cells, which often entirely surround it. I have not encountered a single exception in this respect, and I believe that one can boldly exclude from the family of Rubiaceae every plant of which the stomatal apparatus does not present this configuration." Vesque. loc. cit., 193.

[3] The hairs in Rubiaceae are "very rarely [both] elongated and unicellular." Vesque, loc. cit., p. 192.

"The midnerve of the large-lobed leaves of *Pentagonia laciniata* is armed with short hooked hairs, whose form is probably the result of adaptation to a sort of clambering, which allows the leaves to support themselves on neighboring plants, a method of clambering which one finds greatly developed in several Galieae (Galium, Asperula, Rubia); with these last plants the hair is reduced to a great curved cell borne at the summit of a more or less considerable emergence." Loc. cit., pp. 192-193.

As *Galium hispidulum* does not support itself upon other plants, its possession of hairs of this type is to be attributed not to adaptation to an existing condition, but to the retention of an inherited character which was formerly useful.

Hairs almost identical with those of *G. hispidulum* occur in *Triosteum perfoliatum*, as figured by Vesque, loc. cit., *t. 9, f. 2*.

[4] Radlkofer (Über Pflanzen mit durchsichtigen punktierten Blättern, p. 319; quoted by Solereder, in Engler's Bot. Jahrb., vol. 10, p. 415) found secretion cells in the leaf epidermis of some species of Rubia. Epidermal cells of this type are not common, although occurring in most Aristolochiaceae (see under *Asarum virginicum*), in Monimiaceae, Myrtaceae, and a few other families.

Palisade in one or two layers of rather short cells, passing without sharp demarkation into the open pneumatic tissue.[1]

Mestome bundles completely embedded in the chlorenchyma,[2] each surrounded by a one-layer sheath of delicate, small-celled, colorless parenchyma. Collenchymatic hypodermal parenchyma in small quantity beneath the midvein.

Stem four-angled, the angles winged, the wings composed of strong peripheral groups of thick-walled stereome, and of compact chlorenchyma toward the circumference of the stem proper. Mestome cylinder entirely surrounded by a thin-walled endodermis. Medullary rays very narrow. Pith occupying the center of the stem, finally breaking down and producing a lacuna.

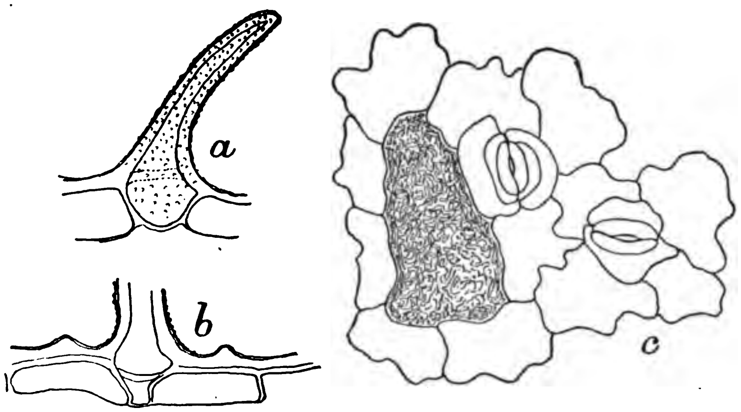

FIG. 90. *Galium hispidulum*, leaf. *a* and *b*, Hairs from upper surface; *c*, portion of lower epidermis showing stomata as secretion cells. Magnified 360 times.

LONICERA SEMPERVIRENS L.

In various situations, but most abundant on the inner sand dunes.

Leaf bifacial, dark green above, glaucous beneath, more or less persistent, midvein prominent beneath, under surface sparsely pubescent when young.

Epidermis: Ventral, radial cell walls straight, thin; cuticle very thick, roughened. *Dorsal*, cell walls thin, the radial undulate; cuticle bearing a coating of wax. Stomata confined to the dorsal surface, small, numerous, lying in all directions, level with the surface, each bordered by four or five ordinary epidermal cells. Hairs numerous beneath, especially along the veins, straight or curved, pointed, with rather thick cuticle, unicellular.[1]

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[1] "Raphides-holding cells occur in the mesophyll beneath the palisade, and sometimes in the parenchyma of the nerves of all Galieae studied." Vesque, loc. cit., p. 193. I did not detect raphides in the leaves or stems of *G. hispidulum.*

[2] "In general the bundles [in Rubiaceae] are completely immersed in the mesophyll: that is to say, the tissues pass above and below the bundles without undergoing the least change." Vesque, loc. cit., p. 202.

Palisade (typical) in one layer. Pneumatic tissue in older leaves quite open, with large lacunes.

Hypodermal collenchyma in one to three layers above and two or three beneath the larger veins, separated from the mestome bundles by several layers of colorless parenchyma above and beneath, that adjoining the collenchyma thickish-walled. Inner walls of the epidermis cells also collenchymatically thickened above and beneath the larger veins.

Mestome bundles bicollateral, leptome in much smaller quantity above than beneath the hadrome.

PLUCHEA FOETIDA (L.) B. S. P.

Low Marsh formation, growing in shallow pools and ditches.

Leaf bifacial, nearly horizontal, veins prominent, almost rugose beneath.

Epidermis: Cells large, the walls thickish, the radial very slightly undulate on the ventral surface, strongly so on the dorsal surface.

Stomata confined to the under surface, lying in all directions, somewhat prominent, each bordered by three or four ordinary epidermis cells. Hairs abundant on both faces; glandular, short, stout, pluricellular, uniseriate.

Chlorenchyma nearly homogeneous, rather open, typical palisade none.

Hypodermal collenchyma in two or three layers above and below the principal veins. Mestome bundles collateral, reenforced by stereome above and below, this separated from the collenchyma by thin-walled parenchyma.

BACCHARIS HALIMIFOLIA L.

Although the leaf anatomy of this species was treated in the above-quoted paper on "The plant covering of Ocracoke Island,"[2] certain emendations are to be made to the description there given.

The epidermis cell walls, even the outer, are only moderately thickened, except over the larger veins. The cuticle is conspicuously wrinkled. Few-celled, capitate, glandular hairs occur in groups occupying small depressions on both ventral and dorsal surfaces, each group of hairs being surrounded by a circle of wedge-shaped foot cells.

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[1] Vesque (Ann. de. Sc. Nat. Bot., ser. 7, vol. 1, p. 185) describes glandular capitate hairs as characteristic of Caprifoliaceae; and Solereder (Bull. de l'Herb. Boissier, vol. 1, p. 171; Syst. Anat., p. 497) believes them to be present throughout the family, saving in the anomalous genus Alseuosmia. I failed to detect such hairs in *Lonicera sempervirens*, even in young leaves which were well provided with the long, pointed hairs.

[2] Contr. U.S. Nat. Herb. 5, p. 307. 1900.

Palisade occurs in about two layers of cells on each leaf face, those on the ventral face being somewhat more elongated, and is much interrupted on both faces by the hypostomatal air chambers. The chlorenchyma of the interior of the leaf is shorter-celled, with numerous intercellular spaces, but is not typical pneumatic tissue.

The stems of this species, as described by Heering,[1] from cultivated material, have very prominent stomata, chlorenchyma composed of roundish cells rich in chlorophyll, and strands of collenchyma in the salient angles.

SENECIO TOMENTOSUS Michx.

Cleared land (noncultural), Herbaceous formation, inhabiting moist open ground.

Leaves (especially the radical), nearly vertical, approximately isolateral, arachnoid-tomentous, especially when young.

Epidermis: Ventral, cells large, the walls not undulate; cuticle roughened. *Dorsal*, cell walls thinner, undulate. Stomata somewhat more numerous on the dorsal surface, large, lying in all directions, level with the surface, each bordered by three to five (mostly four) undifferentiated epidermis cells. Hairs weak, flexuous, blunt-pointed, thin-walled, with slightly roughened cuticle, unicellular, more abundant on the lower than the upper surface (especially in older leaves).

Chlorenchyma homogeneous, with no well-differentiated palisade.

Midvein prominent beneath, composed of several (usually four) mestome bundles, of which one, in the material examined, had its greatest transverse diameter at right angles to the leaf surface. Bundles bicollateral, perileptomatic (the leptome almost entirely surrounding the hadrome, but much more strongly developed on one side), separated from each other and from the epidermis by much colorless, thin-walled parenchyma. Stereome groups adjoining the leptome usually on both sides of the bundle, but much stronger on the side where the leptome is most developed. Hypodermal collenchymatic tissue in several layers beneath the midvein. Hypodermal collenchyma in the leaf margins.

LIST OF THE PLANTS COLLECTED OR OBSERVED.

The species enumerated in the following list were collected within the limits of the Dismal Swamp region as above defined, with the exception of a considerable number which were obtained near Newbern, N. C., and which are included for the sake of recording their occurrence at that station. Where the specimen was collected in North Carolina, the name of the State is given with the station. Where this is omitted, the station is understood to be in Virginia. Species of which specimens were collected are so denoted by the collection number; others here recorded are such as were carefully noted on the spot, and concerning the identity of which there could be no reasonable doubt. Numbers 1 to 115, denoted by the initials "C. & K," were collected by Mr. Frederick V. Coville and the author.

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[1] Engler's Bot. Jahrb., vol. 27, p. 457. 1899.

THALLOPHYTA.

FUNGI.[1]

Exobasidium discoideum Ellis. In the Dismal Swamp, May 1, on *Azalea viscosa* L.

Coleosporium sonchi-arvensis (Pers.) Liv. Virginia Beach, Oct. 2, on leaves of *Solidago sempervirens* L.

LICHENES.[2]

Usnea angulata Ach. Near Pungo, Princess Anne County (No. 1159), on the bark of *Pinus taeda* L.

Usnea barbata rubiginea Michx. With the preceding (No. 1159a).

Usnea barbata serotina Schaer (?). With the preceding (No. 1159b).

Usnea trichodea Ach. With the preceding and on the branches of *Taxodium distichum* L.

BRYOPHYTA.

HEPATICAE.[3]

Odontoschisma sphagni Dumort. Margin of Lake Drummond, July 14 (No. 1672), on bases of tree trunks, with *Plagiothecium micans* Sw.

Riccia fluitans L. Floating near the surface of ponds, common (Nos. 1344, 1631).

Trichocolea tomentella Dumort. Stumps, old logs, etc., in the Dismal Swamp (Nos. 1640, 1641a).

MUSCI.

SPHAGNACEAE.[4]

Sphagnum brevicaule Warnstorf sp. nov. Near Newbern, N. C., Aug. 1 (No. 1977), in a small open bog.

Sphagnum cuspidatum plumosum f. serrata Warnstorf. In the Jericho Ditch, Dismal Swamp, July 15 (No. 1676), entirely submersed.

Sphagnum cymbifolium glaucescens Russ. In the Dismal Swamp and in swales in the Desert, Cape Henry, July 14, 27 (Nos. 1673, 1861a).

Sphagnum cymbifolium glaucescens Russ. **f. squarrulosa** Warnstorf. With the preceding (Nos. 1675, 1860).

Sphagnum henryense Warnstorf, sp. nov. In a swale in the Desert, Cape Henry, July 27 (No. 1861).

Sphagnum imbricatum cristatum Warnstorf **f. glaucescens** Warnstorf. Near Newbern, N. C., Aug. 1 (No. 1975).

Sphagnum kearneyi Warnstorf, sp. nov. In the Jericho Ditch, Dismal Swamp, July 15 (No. 1677), all but the summits of the stems submersed, stems sometimes 4.5 dm. long.

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[1] Determined by Mrs. Flora W. Patterson.

[2] Determined by Mr. T. A. Williams.

[3] Determined by Mr. O. F. Cook.

[4] Determined by Dr. C. Warnstorf. See Hedwigia, vol. 39, pp. 101 to 109 (1900), for descriptions of the new species.

Sphagnum medium glaucescens Warnstorf. Virginia Beach, Oct. 2 (No. 2091), in a marshy place in the pine woods.

Sphagnum recurvum ambliphyllum f. pulchricoma C. Muell. In swales in the Desert, Cape Henry, July 27 (No. 1861b).

Sphagnum virginianum Warnstorf, n. sp. Margin Lake Drummond, Dismal Swamp, July 14 (1668).

BRYACEAE.[1]

Aulacomnium palustre (L.) Schwaegr. Margin of Lake Drummond (No. 1655).

Aulacomnium palustre polycephalum Bruch & Schimp. On an old tree stump, Dismal Swamp (No. 2352).

Aulacomnium sp. With the preceding (No. 2351).

Dicranum flagellare Hedw. On decaying logs, Dismal Swamp (Nos. 1612, 1654, 1674).

Dicranum scoparium (L.) Hedw. On the ground in moist woods; along Cohoon Creek, near Suffolk (No. 1710); the Desert, Cape Henry (No. 1835).

Funaria hygrometrica (L.) Sibth. Moist soil, Virginia Beach (No. 1419); abundant along the Dismal Swamp Canal.

Funaria hygrometrica calvescens Bruch & Schimp. Moist soil, Virginia Beach (No. 1423).

Hypnum boscii Schwaegr. On old stumps and logs, border of Lake Drummond (No. 2363).

Hypnum cupressiforme L. On a moist bank at roadside, Northwest (No. 2373).

Hypnum spp. Undetermined, material insufficient. (Nos. 1642, 1787, 1849.)

Leptodon trichomitrion (Hedw.) Mohr. On old logs and stumps, Dismal Swamp (No. 1642).

Leucobryum albidum Brid. *L. minus* Sull., not Michx.) Moist ground, near margin of Lake Drummond (Nos. 1670, 1671).

Leucobryum glaucum (L.) Schimp. On a moist bank at roadside, Northwest (Nos. 2373a, 2374).

Leucodon brachypus Brid. (No. 215a.)

Leucodon julaceus (Hedw.) Sull. On the bark of Liquidambar and other trees, Wallaceton (No. 1789); Virginia Beach (No. 2150).

Mnium affine Bland. On old logs and stumps, Dismal Swamp (No. 1641).

Plagiothecium latebricola Bruch & Schimp. (No. 2351.)

Plagiothecium micans Sw. Near the margin of Lake Drummond (No. 1672a).

Polytrichum commune L. Moist ground: Northwest (Nos. 1509, 2369); Wallaceton (1791); common.

Polytrichum ohiense R. & C. Kempsville, Princess Anne County (No. 1048).

Raphidostegium microcarpum (Muell) Jaeg. & Sauerb. Near the margin of Lake Drummond (No. 1662).

Thelia hirtella (Hedw.) Sull. On the bark of *Acer rubrum*, Dismal Swamp (No. 1790).

Thuidium recognitum (Hedw.) Lindb. On old logs and stumps in the Dismal Swamp (Nos. 1641 b, 1656, 2364).

Thuidium scitum (Beauv.) Aust. On old logs in the Dismal Swamp (No. 1786).

PTERIDOPHYTA.

OSMUNDACEAE.

Osmunda cinnamomea L. Common in shaded swamps (Nos. 1214, 1628, 2159).

Osmunda regalis L. With the preceding, but less common (No. 100 C. & K).

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[1] Determined by Mrs. Elizabeth G. Britton.

POLYPODIACEAE.[1]

Polystichum acrostichoides (Michx.) Schott. Near Suffolk (No. 1237) and at Virginia Beach, in rich woods.

Dryopteris spinulosa dilatata (Hoffm.) Underw. Margin Lake Drummond, Dismal Swamp (No. 108, C. & K.).

Woodwardia areolata (L.) Moore. Common in bogs and swamps (Nos. 1625, 2130, 2360).

Woodwardia virginica (L.) J. E. Smith. Common in open swamps (Nos. 1151, 1351, 1591, 1678.)

Asplenium filix-foemina (L.) Bernh. Near Virginia Beach, May 29 (No. 1410), in rich woods.

Pteris aquilina L. Common, especially in low ground.

Pellaea atropurpurea (L.) Link. On brick walls, in Norfolk.

Polypodium polyodioides (L.) Hitchcock. Abundant on the limbs of *Taxodium distichum* L., in the Dismal Swamp (No. 113 C. & K.).

LYCOPODIACEAE.

Lycopodium alopecuroides L. In marshy places, Newbern, N. C., Aug. 1 (Nos. 1930, 1973).

Lycopodium inundatum L. In open, marshy places: Northwest (No. 1539) and Cape Henry (No. 1825).

SELAGINELLACEAE.

Selaginella apus (L.) Spring. In a shady swamp, Edenton, N. C., July 30 (No. 1918).

EMBRYOPHYTA.

GYMNOSPERMAE.

PINACEAE.

Pinus[2] **echinata** Mill. Near Suffolk (No. 1232); Lynnhaven Bay (No. 1843). Locally known as "rosemary pine," which is said to be the popular name of *P. taeda* in North Carolina.[3]

Pinus taeda L. Everywhere (Nos. 4 and 99, C. & K., 1003, 1060, 1160, 1745, 1806). Locally known as "short-leaf pine."

Taxodium distichum L. Common in swamps and along streams (Nos. 1157, 1916, 2077, 2361).

Chamaecyparis thyoides (L.) B. S. P. Abundant in parts of the Dismal Swamp (Nos. 87 C. & K., 1600, 1663). Locally known as "juniper."

Juniperus virginiana L. Common in woodlands and on roadsides in dry soil (Nos. 1176, 1724).

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[1] For an account of the ferns of the Dismal Swamp see W. Palmer, in Proc. Biol. Soc. Washington, vol. 13, pp. 61 to 70, 1899. The following species, not included here, are enumerated in that paper: *Onoclea sensibilis* L., *Dryopteris noveboracensis* (L.) A. Gray, *Dryopteris thelypteris* (L.) A. Gray, *Dryopteris goldieana celsa* Palmer, *Dryopteris marginalis* (L.) A. Gray, *Dryopteris spinulosa* (Retz) Kuntze, *Asplenium platyneuron* (L.) Oakes, and *Botrychium obliquum* Muhl. Interesting observations are given concerning the distribution and ecology of the species.

[2] Pinus determined by Mr. G. B. Sudworth.

[3] Ashe, Bull. N. C. Geolog. Surv., vol. 5, p. 15 (1894). "Short-leaf pine" is there given as the popular name for *P. echinata*.

ANGIOSPERMAE.

MONOCOTYLEDONES.

TYPHACEAE.

Typha angustifolia L. Common in fresh-water river marshes (Nos. 1349, 1518, 1522).

Typha latifolia L. More abundant than the preceding, in fresh and brackish marshes.

Sparganium androcladum (Engelm.) Morong. In the cool, shaded water of Washington Ditch, Dismal Swamp, July 14 (No. 1627).

NAIADACEAE.

Potamogeton lonchites Tuckerm. With *Sparganium androcladum* (No. 1626).

ALISMACEAE.

Echinodorus radicans (Nutt.) Engelm. In shaded swamp, Edenton, N. C., July 30 (No. 1915).

Sagittaria graminea Michx. In an open, grassy bog, Newbern, N. C., August 1, (No. 1952).

Sagittaria lancifolia L. Common in fresh-water river marshes (No. 1359, 1713, 1717, 2011).

VALLISNERIACEAE.

Philotria canadensis (Michx.) Britton. Bottom of Nansemond River, near Suffolk (No. 1697). An unusually small, slender, short-leaved form.

POACEAE.

Erianthus contortus Ell. Common along ditches, in fields, and at the edge of woodlands, near Norfolk and Portsmouth (Nos. 1741, 2398).

Erianthus saccharoides Michx. In open marshes, especially on the border of the Dismal Swamp (Nos. 2146, 2354). Occasional in drier soil.

Andropogon argyraeus Schult. Dry soil at roadsides (No. 2149).

Andropogon elliottii Chapm. Dry soil at roadsides and at the edges of woodlands, near Northwest (No. 2383); a slender form approaching var. *gracilior* Hack.

Andropogon glomeratus (Walt.) B. S. P. In open, boggy places; at Ocean View.

Andropogon scoparius Michx. Common in dry, sandy soil, at roadsides and in fields.

Andropogon sorghum halepensis (L.) Hack. Persisting as a weed in cultivated land at Wallaceton, Norfolk County. Introduced.

Andropogon tetrastachyus Ell. In a swale at Cape Henry, October 5 (No. 2129).

Andropogon virginicus L. Abundant in old fields.

Paspalum angustifolium Le Conte. In moist, sandy soil along the Dismal Swamp Canal, Wallaceton, Norfolk County, July 21 (No. 1785).

Paspalum dasyphyllum Ell. In pine woods on Lynnhaven Bay, July 27 (No. 1856).

Paspalum distichum L. Brackish marshes near Virginia Beach, August 4 (No. 2028).

Paspalum floridanum Michx. Dry soil in an old field, Kempsville, Princess Anne County, October 7 (No. 2168).

Paspalum floridanum glabratum Engelm. In dry fields near Lynnhaven Bay, October 3 (No. 2142.)

Paspalum laeve Michx. Roadside near Ocean View, July 8 (No. 1473).

Paspalum longipedunculatum Le Conte. With the preceding (No. 1474).

Paspalum paspaloides (Michx.) Scribn. Moist, sandy soil near Virginia Beach, August 3 (No. 2012).

Paspalum purpurascens Ell. Cornfields, near Wallaceton, Norfolk County, November 4 (No. 2341); and near Newbern, N. C., July 21 (No. 1951).

Syntherisma filiforme (L.) Nash. Dry, sandy roadsides near Virginia Beach, October 5 (2104).

Syntherisma sanguinale (L.) Nash. Abundant in cultivated and fallow land, waste ground, etc. Introduced.

Panicum[1] **agrostoides** Muhl. Grassy marshes near Newbern, N. C., October 10 (No. 2249). Form approaching *P. longifolium* Torr., with preceding (No. 2242), and in slightly brackish marshes near Virginia Beach, August 4 (No. 2025).

Panicum amarum Ell. Abundant on the strand (No. 1405, 1775, 2021, 2063).

Panicum amarum minus Vasey & Scribn. With, but more abundant than, the type (Nos. 1401, 2064). Differs from the type form in its more widely creeping rootstocks, more numerous innovations, more slender, contracted panicle, and fewer spikelets. Anatomically identical, at least as to the leaves.[2]

Panicum angustifolium Ell. (?) Dry, sandy soil, Portsmouth (No. 1369) and Virginia Beach (No. 1416).

Panicum barbulatum Michx. Rather common in partly shaded bogs (No. 1307).

Panicum ciliatum Ell. Moist sandy soil in pine woods near Ocean View, July 20 (No. 1761).

Panicum colonum L. Low ground, Virginia Beach, August 5 (No. 2049). Introduced.

Panicum commonsianum Ashe. Among sand dunes, Ocean View to Virginia Beach (No. 1447). Doubtful forms of this species are Nos. 1393, 1454, and 1776, the first being a very hairy form, the other two apparently representing the branched condition.

Panicum commutatum Schult. Common in low woods, May (Nos. 1029, 1317, 1414, 1463).

Panicum crus-galli L. Abundant in fields and waste ground. Introduced. (No. 2187.)

Panicum dichotomum L. Common in woodlands. May (No. 1374).

Panicum gibbum Ell. Margin Lake Drummond (No. 1618); border of a pond near Virginia Beach (No. 2122).

Panicum latifolium L. Common in woodlands, May (Nos. 1411, 1469).

Panicum laxiflorum Lam. Low, moist, shaded ground, common. May (Nos. 1033, 1104, 1179, 1308, 1467).

Panicum microcarpon Muhl. Low ground in open pine woods, Ocean View, July 8 (No. 1476).

Panicum neuranthum Griseb. Dry sandy soil: Northwest, July 9 (No. 1566; near Virginia Beach, August 4 (No. 2038): near Edenton, N. C., July 29 (No. 1871).

Panicum pauciflorum Ell. Among the inner dunes; Virginia Beach, May 28 (No. 1386): Cape Henry, May 28 (No. 1400).

Panicum pubescens Lam. Frequent in dry sandy soil (Nos. 1461, 1559, 2043).

Panicum rostratum Muhl. Low ground, common (No. 1748).

Panicum scabriusculum Ell. Along Dismal Swamp Canal, Wallaceton, July 22 (No. 1798).

Panicum sphaerocarpon Ell. In rather dry soil, Northwest, July 9 (No. 1560).

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[1] Species of Panicum of the *dichotomum* section determined by Mr. Geo. V. Nash.

[2] See Contr. Nat. Herb., vol. 5, p. 285.

Panicum sphagnicola Nash. In a moist meadow near the river, Northwest, July 9 (No. 1514); in an open marsh near the beach, below Virginia Beach, August 4 (No. 2026).

Panicum verrucosum Muhl. Frequent in moist, low, shaded ground (No. 2053).

Panicum virgatum L. Edge of a brackish marsh, Virginia Beach, August 3 (No. 2018). In grassy swales, Edenton, N. C., July 28 (No. 1899), a variety with culms only one to three from each rootstock, and a small, open, few-flowered panicle.

Panicum viscidum Ell. Common in ditches and low ground (No. 1477).

Panicum sp. (No. 1375.)

Panicum sp. (No. 2114.) Near *P. pubescens* Lam.

Chaetochloa glauca (L.) Scribner. Abundant in fields and roadsides (No. 2158). Introduced.

Chaetochloa imberbis (Poir.) Scribner. Low ground near Nansemond River, Suffolk, July 18 (No. 1735); in ditches near Berkley.

Chaetochloa imberbis perennis (Hall) Scribn. & Merrill. Marshes bordering lagoon below Virginia Beach, August 4 (No. 20,35).

Chaetochloa ventenatii (Kunth) Nash[1] (?). Dry sandy roadside near Newbern, N. C., October 10 (No. 2221).

Cenchrus tribuloides macrocephalus Doell. Common on the sand strand, Ocean View to Virginia Beach (Nos. 1813, 1814, 1948).

Zizania aquatica L. Fresh-water marshes. Along Nansemond River, Suffolk, July 18; near Edenton, N. C., July 30.

Homalocenchrus oryzoides (L.) Poll. Marshes.

Homalocenchrus virginicus (Willd.) Britton. Wet shaded ground.

Anthoxanthum odoratum L. Grassy fields and roadsides, common (No. 1274). Introduced.

Stipa avenacea L. Dry pine woods, frequent (No. 1102).

Aristida dichotoma Michx. Dry sandy fields, Kempsville, Princess Anne County, October 7 (No. 2171).

Aristida purpurascens Poir. Dry woodlands near Virginia Beach, October 4 (No. 2117).

Aristida stricta Michx. Pine barrens, Newbern, N. C.

Muhlenbergia capillaris (Lam.) Trin. Dry sandy roadside, Newbern, N. C., October 10 (No. 2206).

Phleum pratense L. Fields and roadsides, common. Introduced.

Alopecurus geniculatus L. Rather moist, sandy soil along railways, Princess Anne County, May 13 (No. 1147).

Sporobolus asper (Michx.) Kunth. Dry pine woods, Lynnhaven Bay, October 4 (No. 2113).

Sporobolus indicus (L.) R. Br. Common at roadsides, Newbern, N. C. Introduced.

Agrostis alba L. Moist ground at roadsides, Northwest, July 9 (No. 1546). Introduced.

Agrostis alba vulgaris (With.) Thurb. Common in fields and roadsides. Introduced.

Agrostis hiemalis (Walt.) B. S. P. Sandy fields and roadsides, common (Nos. 1205, 1409).

Agrostis intermedia Scribner. Shaded banks, Virginia Beach, October 2 (No. 2073): Northwest, November 8 (No. 2382), a large form, very near *A. altissima* (Walt.) Tuckerm.

Ammophila arenaria (L.) Link. Abundant on the sand strand, Lamberts Point to Virginia Beach (Nos. 1017, 1406, 1770, 1811).

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[1] *Setaria ventenatii* Kunth, Rév. Gram. 1: 251, *t.* 37.

Holcus lanatus L. Roadsides, occasional. Introduced.

Aira caryophyllea L. Common in sandy fields (No. 1279). Introduced.

Aira praecox L. Dry sandy soil in pine woods, Virginia Beach, May 28 (No. 1379). Introduced.

Trisetum pennsylvanicum (L.) Beauv. Shaded marshy ground at edge of forest, frequent, May (No. 1044).

Danthonia sericea Nutt. Dry sandy soil in pine woods, frequent (Nos. 1129, 1219).

Danthonia spicata (L.) Beauv. Dry soil on roadsides and in open woods, common (No. 1203).

Capriola dactylon (L.) Pers. Abundant on roadsides and in lawns, waste ground, etc., (No. 1517). Introduced.

Spartina patens (Ait.) Muhl. Common along the coast; a tall, stout form on the sand strand (Nos. 1694, 1815); a low, slender form in the salt marshes.

Spartina stricta maritima (Walt.) Scribn. Abundant in salt marshes (No. 2112).

Campulosus aromaticus (Walt.) Scribn. Open grassy pine barrens, Newbern, N. C.

Gymnopogon ambiguus (Michx.) B. S. P. Dry sandy uplands, near Suffolk.

Eleusine indica (L.) Gaertn. Fields and waste ground, common. Introduced.

Dactyloctenium aegyptiacum (L.) Willd. Cornfields, Newbern, N. C., October 10. Introduced.

Phragmites communis Trin. Occasional in brackish marshes.

Sieglingia seslerioides (Michx.) Scribner. Dry fields and open woods near Virginia Beach.

Triplasis purpurea (Nutt.) Chapm. Frequent among the dunes, Cape Henry to Virginia Beach (Nos. 1817, 2092).

Eragrostis hirsuta (Michx.) Nash. Sandy roadsides, Norfolk, August 5, 1895; Newbern, N. C., August 1 (No. 1968).

Eragrostis major Host. Roadsides, fields, etc. Introduced.

Eragrostis pectinacea (Michx.) Steud. Among the inner dunes near Virginia Beach, October 2 (No. 2087).

Eragrostis pilosa (L.) Beauv. Sandy roadside, Wallaceton, July 22 (No. 1801).

Eragrostis refracta (Muhl.) Scribner. Sandy roadside, Edenton, N. C., July 29 (No. 1922); low pine woods, Virginia Beach, October 2 (No. 2050).

Eatonia nitida (Spreng.) Nash. Open woodlands and borders of woods, near Suffolk, May 19 (No. 1240); Virginia Beach, May 29 (No. 1420). A form with the empty glumes, especially the second, scabrous toward the apex, the flowering glume distinctly scabrous.

Eatonia obtusata (Michx.) A. Gray. Open woods and edges of woods, in fertile soil (Nos. 1114, 1119, 1371).

Melica mutica Walt. Rich soil in woods, Virginia Beach, May 29 (No. 1418).

Uniola latifolia Michx. Bluff on Cohoon Creek above Suffolk, overhanging the water in shaded places.

Uniola longifolia Scribn. In fertile soil in a copse at roadside near Virginia Beach, October 1 (No. 2107).

Uniola laxa (L.) B. S. P. Frequent in low pine woods (No. 1475).

Uniola paniculata L. Frequent on the outer dunes near Cape Henry (Nos. 1753, 2134).

Distichlis spicata (L.) Greene. Brackish meadow near Virginia Beach, August 4 (No. 2030).

Dactylis glomerata L. Common along ditches at roadsides, etc. (No. 1291). Introduced.

Poa annua L. Roadsides and waste ground (No. 1283). Introduced.

Poa autumnalis Muhl. Frequent in moist low woodlands (Nos. 1049, 1141).

Poa compressa L. Fields and roadsides, common (No. 1496). Introduced.

Poa pratensis L. Common, especially at roadsides (No. 1142). Introduced.

Panicularia brachyphylla Nash. Rich swampy woods, margin of Lake Drummond, May 2 (No. 115 C. & K.).

Panicularia obtusa (Muhl.) Kuntze. Shaded swamp near Elizabeth City, N. C., August 2 (No. 2003).

Panicularia pallida (Torr.) Kuntze. Marshy ground near Portsmouth, May 18 (No. 1152); margin of Lake Drummond, July 18 (No. 1617).

Festuca elatior L. Frequent along ditches (No. 1287). Introduced.

Festuca myuros L. Sandy fields and roadsides, May (Nos. 1324, 1427).

Festuca octoflora Walt. Sandy fields and roadsides, common, May (Nos. 1267, 1272, 1370, 1403).

Festuca rubra L. Shore of Lynnhaven Bay, July 27 (No. 1855).

Festuca sciurea Nutt. Sandy field near Deep Creek, Norfolk County, May 17 (No. 1204).

Bromus secalinus L. Along railways, waste ground, etc., May (Nos. 1321, 1322). Introduced.

Hordeum pusillum Nutt. Fields and waysides, abundant, May (Nos. 1028, 1229). Introduced.

Elymus virginicus L. Along ditches, common (No. 1690).

Arundinaria macrosperma Michx. Wooded swamps, abundant, May (Nos. 86 C. & K., 1590, 1623). Known locally as "reeds."

Arundinaria tecta (Walt.) Muhl. Moist open woods, abundant, May (Nos. 1038, 1845).

CYPERACEAE.[1]

Cyperus cylindricus (Ell.) Britton. Common on the inner sand dunes (Nos. 1510, 1538, 1744, 2017).

Cyperus diandrus Torr. Open marsh, Cape Henry, October 5 (No. 2127a).

Cyperus erythrorhizos Muhl. Bank of the Dismal Swamp Canal, Wallaceton, Norfolk County, November 3 (No. 2343).

Cyperus esculentus L. Sandy soil along Lynnhaven Bay, July 27 (No. 1854).

Cyperus filiculmis Vahl. Sandy soil along Lynnhaven Bay, July 27 (No. 1852).

Cyperus flavescens L. Moist ground at roadside, Deep Creek, July 22 (No. 1780); moist sand near the shore, Virginia Beach, August 3 (No. 2037).

Cyperus flavicomus Michx. Moist open ground at roadsides; near Lamberts Point, July 16 (No. 1691); Newbern, N. C., August 1, October 10 (Nos. 1969, 2212).

Cyperus grayi Torr. Common among the sand dunes, Ocean View to Virginia Beach (No. 1778).

Cyperus haspan L. River marshes, Elizabeth City, N. C., August 3 (No. 1995); Northwest, November 8 (No. 2390).

Cyperus microdontus Torr. Moist ground at roadside, Deep Creek, Norfolk County (No. 1783).

Cyperus nuttallii Eddy. Moist ground near the beach, Virginia Beach, August 4, October 2 (Nos. 2066, 2127).

Cyperus ovularis (Michx.) Torr. Dry soil among undergrowth, Ocean View, July 8 (No. 1480).

Cyperus pseudovegetus Steud. Marshy ground and ditches at roadsides, frequent (Nos. 1479, 1889, 2161).

Cyperus retrofractus (L.) Torr. In sandy soil at roadside, Suffolk, July 11 (No. 1582).

Cyperus rotundus L. In a garden, Suffolk, July 11 (No. 1567). Introduced.

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[1] Determined by Dr. N. L. Britton.

Cyperus strigosus L. Frequent in moist low ground (Nos. 2000, 2153, 2169, 2239).

Kyllinga pumila Michx. In a moist cornfield, Wallaceton, Norfolk County, November 3 (No. 2333).

Dulichium arundinaceum (L.) Britton. Along ditches in the Dismal Swamp; common; July 12 (No. 1593).

Eleocharis engelmanni Steud. Marshy ground in woods, Kempsville, Princess Anne County, October 7 (No. 2182).

Eleocharis mutata (L.) Roem. & Schult. In a pond in the Dismal Swamp, July 13 (No. 1632); in a marshy meadow near Virginia Beach, August 4 (No. 2027)

Eleocharis ochreata (Nees) Steud. In a marshy spot among the dunes, Cape Henry, July 26 (No. 1821).

Eleocharis ovata (Roth) R. Br. In open roadside marshes, Northwest, Norfolk County, July 9 (Nos. 1543, 1554).

Eleocharis glaucescens (Willd.) Schultes. Marshy banks of the Northwest River, May 11 (No. 1084); marshy meadow near Virginia Beach, August 4 (No. 2029), the latter number doubtfully referred here.

Eleocharis prolifera Torr. (?) In a pool in "The Desert," Cape Henry, July 27 (No. 1832). The specimen is without fruiting spikes.

Eleocharis tenuis (Willd.) Schultes. Marshy places, Kempsville, Princess Anne County, May 9 (No. 1041).

Eleocharis tortilis (Link) Schultes. Sedgy marshes at roadsides, Edenton, N. C., July 29 (Nos. 1870, 1876).

Eleocharis tuberculosa (Michx.) Roem. & Schult. Along the Dismal Swamp Canal, Wallaceton, Norfolk County, November 4 (No. 2348).

Dichromena colorata (L.) A. S. Hitchcock. In a grassy open bog, Newbern, N. C., July 31 (No. 1959).

Stenophyllus capillaris (L.) Britton. Sandy margin of a pond, Ocean View, July 8 (No. 1456).

Fimbristylis autumnalis (L.) Roem. & Schult. Frequent in moist sandy soil (Nos. 1822, 2334).

Fimbristylis laxa Vahl. In muddy places at a roadside, Virginia Beach, October 4 (No. 2152).

Fimbristylis spadicea (L.) Vahl. Common along the coast in the marshes and in moist places among the dunes (Nos. 1695, 1772).

Scirpus americanus Pers. Usually with the preceding, common; also in the nearly fresh-water river marshes at Suffolk (Nos. 1218, 1506, 1810).

Scirpus cyperinus eriophorum (Michx.) Britton. Abundant in the open lands in and bordering upon the Dismal Swamp, also in fresh-water river marshes (Nos. 1629, 2081).

Scirpus divaricatus Ell. In a shallow pond in the Dismal Swamp, July 13 (No. 1633).

Scirpus lacustris L. River marshes, at and above the upper limit of brackish water (No. 1358).

Eriophorum virginicum L. On hummocks, among Sphagnum and *Woodwardia virginica*, in the Dismal Swamp, July 15 (No. 1681).

Fuirena squarrosa Michx. In moist sand on the beach. Virginia Beach, August 4, October 2 (Nos. 2039, 2067); in a grassy bog, Newbern, N. C., August 1 (No. 1963).

Lipocarpha maculata (Michx.) Torr. In moist shaded ground: Edenton, N. C., July 29 (No. 1919); Virginia Beach, August 3.

Rynchospora axillaris (Lam.) Britton. Along the Dismal Swamp Canal, Wallaceton, November 3 (No. 2342), near var. *microcephala*.

Rynchospora axillaris microcephala Britton. In a low grassy meadow, Newbern, N. C., October 10 (No. 2236).

Rynchospora corniculata (Lam.) A. Gray. In a shallow pool in the Dismal Swamp, July 14 (No. 1638); in a ditch, Edenton, N. C., July 29 (No. 1892).

Rynchospora cymosa Ell. In open marshy meadows: Northwest, July 9 (No. 1536); Cape Henry, July 26 (No. 1826); Newbern, N. C., August 1 (No. 1974).

Rynchospora fascicularis (Michx.) Vahl. In a small open marsh, Newbern, N. C., October 10 (No. 2235).

Rynchospora glomerata (L.) Vahl. Common in open bogs (Nos. 1491, 1781, 1782).

Rynchospora glomerata paniculata (A. Gray) Chapm. Along a roadside ditch, Virginia Beach, October 10 (No. 2139).

Rynchospora inexpansa (Michx.) Vahl. In open sedgy bogs: Berkley, July 19 (No. 1743); Edenton, N. C., July 29 (No. 1886).

Rynchospora schoenoides (Ell.) Britton. Marshes on Pasquotank River, Elizabeth City, N. C., August 2 (No. 1993).

Cladium effusum Torr. Fresh-water river marshes: Northwest, July 9 (No. 1557); Elizabeth City, N. C., August 2 (No. 2006).

Scleria pauciflora Muhl. In an open grassy pine grove, Edenton, N. C., July 29 (No. 1887); dry open ground, Elizabeth City, N. C., August 3 (No. 2001).

Scleria triglomerata Michx. Dry sandy soil on Lynnhaven Bay, July 27 (No. 1848).

Carex albolutescens Schwein. Common in moist sandy soil, May–July (Nos. 1148, 1399, 1459, 1793).

Carex alata Torr. In marshy ground, Ocean View, May 30 (No. 1435).

Carex bullata Schk. Margin Lake Drummond, Dismal Swamp, July 14 (No, 1609).

Carex canescens L. Marshy banks of the Northwest River, May 11 (Nos. 1077, 1082).

Carex comosa Boott. Marshy banks of the Northwest River, July 9 (No. 1541).

Carex costellata Britton. In open woods, Ocean View, July 8 (No. 1471).

Carex glaucodea Tuckerm. Moist ground near Kempsville, Princess Anne County, May 9 (No. 1053).

Carex gynandra Schwein. In a shaded swamp, Deep Creek, Norfolk County, May 17 (No. 1207).

Carex laxiflora Lam. Frequent in low woodlands, May (Nos. 1006, 1191, 1424).

Carex lupulina Muhl. (?) Along Jericho Ditch, Dismal Swamp, May 1 (No. 98 C. & K.). Immature.

Carex lurida Wahl. Common in marshes. May–July (Nos. 1086, 1162, 1346, 1505).

Carex pedicellata (Dewey) Britton. Upland sandy woods near Suffolk, April 30 (No. 66 C. & K.).

Carex pennsylvanica Lam. Sandy pine woods near Virginia Beach, April 29 (No. 40 C. & K.).

Carex rosea Schk. Low woodlands, Kempsville, Princess Anne County, May 9 (No. 1046).

Carex scoparia Schk. Along a railway near Suffolk, May 19 (No. 1273).

Carex sterilis Willd. Marshy banks of the Northwest River, May 11 (Nos. 1080. 1099).

Carex stipata Muhl. In a swamp at Northwest, May 11 (No. 1107).

Carex stricta Lam. Marshy banks of the Northwest River, May 11 (No. 1083). Forming strong tussocks.

Carex tenuis Rudge. Deep, moist woods near Pungo, Princess Anne County, May 14 (No. 1169).

Carex triceps Michx. In sandy soil, fields, and dry woodlands, common, May (Nos. 1185, 1199, 1306, 1367, 1432).

Carex verrucosa Muhl. Sandy banks of the Dismal Swamp Canal, Wallaceton, November 4; in a grassy swale, "The Desert," Cape Henry, July 27 (No. 1844); in marshes and along ditches, especially in pine woods, Newbern (No. 1970) and Elizabeth City (No. 2002), N. C.

Carex virescens Muhl. Swampy woods, Northwest, Norfolk County, May 11 (No. 1106).

Carex vulpinoidea Michx. In a ditch along the railway, Suffolk, May 19 (No. 1255).

ARACEAE.

Acorus calamus L. Abundant in fresh-water marshes along the Northwest River, May 11 (No. 1085).

Arisaema triphyllum (L.) Torr. In low woods, Ocean View, May 6 (No. 1007).

Peltandra virginica (L.) Kunth. In marshes; near Virginia Beach, May 28 (No. 1381); Elizabeth City, N. C., August 2 (No. 2009).

LEMNACEAE.

Spirodela polyrhiza (L.) Schleid. Covering surface of a bayou, Edenton, N. C., July 29 (No. 1894).

XYRIDACEAE.

Xyris ambigua Beyrich. In an open, sedgy bog, Newbern, N. C., August 1 (No. 1976).

Xyris caroliniana Walt. Frequent in bogs and along ditches, July (Nos. 1685, 1820, 1920).

Xyris torta J. E. Smith. In open, sedgy bogs near Newbern, N. C., August 1 (No. 1984).

Xyris sp. Apparently intermediate between *X. caroliniana* and *X. platylepis* Chapm. In marshy ground in the pine woods, Virginia Beach, October 2 (No. 2088).

ERIOCAULACEAE.

Eriocaulon decangulare L. Marshy banks of the Northwest River, July 9 (No. 1558).

Lachnocaulon anceps (Walt.) Morong. In an open, sedgy bog, Newbern, N. C., August 1 (No. 1910).

BROMELIACEAE.

Tillandsia usneoides L. Not abundant in Virginia; common in North Carolina. On old cypress trees, margin of Lake Drummond, Dismal Swamp, May 2 (No. 73, C. & K.); on the branches of Fagus, *Quercus minor*, *Pinus taeda*, *P. echinata*, etc., about ponds and along Long Creek, in "The Desort," Cape Henry, July 27 (No. 1838).

COMMELINACEAE.

Commelina erecta L. Sandy shores of Lynnhaven Bay, July 27 (No. 1846).

PONTEDERIACEAE.

Pontederia cordata L. Very common in fresh-water river marshes (No. 1551).

JUNCACEAE.[1]

Juncus acuminatus Michx. Common in marshes and shallow water, especially in sandy soil (Nos. 1078, 1431, 1178, 1610, 1639).

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[1] Determined by Mr. Frederick V. Coville.

Juncus acuminatus debilis A. Gray. On made ground, sandy banks of the Dismal Swamp Canal, July 22 (No. 1794).

Juncus canadensis J. Gay. Very common in marshes (Nos. 1624, 1779, 1896, 2248, 2344, 2388).

Juncus dichotomus Ell. Common in low marshy places among the sand dunes, Ocean View to Cape Henry (Nos. 1391, 1460, 1764, 1774).

Juncus effusus L. Abundant in marshes, especially on the edges of palustrine forest (No. 1465).

Juncus marginatus Rostk. Frequent in marshy places (Nos. 1762, 1828, 2379).

Juncus marginatus aristulatus (Michx.) Coville. In open marshes along the Northwest River, July 9 (No. 1540), near Virginia Beach, August 4 (No. 2031).

Juncus repens Michx. Frequent in moist sand or in shallow water, especially in the Dismal Swamp (Nos. 72 C. & K., 1462, 1616, 2349).

Juncus roemerianus Scheele. The most abundant plant in brackish marshes (Nos. 1360, 1696).

Juncus scirpoides Lam. Abundant in moist sandy places, especially among the sand dunes (Nos. 1537, 1771).

Juncus setaceus Rostk. Edge of pond, Ocean View, July 8 (No. 1466).

Juncus tenuis Willd. Common in dry sandy soil (Nos. 1373, 1436, 1444, 1445, 1795).

Juncoides campestre (L.) Kuntze. Dry upland pine woods near Suffolk, May 17 (No. 1238).

Juncoides pilosum (L.) Kuntze. Rich shaded soil along a brook near Suffolk, May 17. With *Kalmia latifolia* L.

LILIACEAE.

Uvularia sessilifolia nitida (Britton) Morong. In rather low open woods near Suffolk, April 30 (No. 62 C. & K.). With *Asarum virginicum*, L.

Hemerocallis fulva L. Roadside near Centerville, Princess Anne County, escaped from gardens.

Allium vineale L. A common weed in fields and roadsides (No. 1486). Introduced.

Nothoscordum bivalve (L.) Britton. Moist low ground, frequent near Virginia Beach, April 29 (No. 13 C. & K.); Munden's Point, Princess Anne County, May 16 (No. 1194).

Lilium superbum L. Swampy banks of Cohoon's Creek, above Suffolk, July 18 (No. 1711).

Yucca filamentosa L. In dry, open pine woods near the beach: Virginia Beach (No. 1380); Lynnhaven Bay.

Asparagus officinalis L. A weed in fields near Berkley, May 21 (No. 1303). Introduced.

Vagnera racemosa (L.) Morong. Rich, low woods near Virginia Beach, May 29 (No. 1418.)

Polygonatum biflorum (Walt.) Ell. Low woods near Berkley, May 21 (No. 1310).

SMILACEAE.

Smilax bona-nox L. Very common, especially in dry, sandy pine woods and among the dunes (Nos. 5 C. & K., 1251, 1385, 2216).

Smilax glauca Walt. Common, usually in dry soil (Nos. 1221, 1394, 1797).

Smilax laurifolia L. Abundant in the more open parts of the wooded swamps (Nos. 36 C. & K., 1525, 1602).

Smilax rotundifolia L. Very common in woods and thickets, preferring rather moist soil (Nos. 9 C. & K., 1010, 1018, 1342, 1636, 1737).

Smilax walteri Pursh. Frequent in the larger wooded swamps (Nos. 89 and 97 C. & K., 1598.)

AMARYLLIDACEAE.

Atamosco atamasco (L.) Greene. Frequent in moist, low ground, especially in open woods (Nos. 1004, 1408).

Hypoxis hirsuta (L.) Coville. Frequent in open woodlands (Nos. 1035, 1265, 1378).

DIOSCOREACEAE.

Dioscorea villosa L. Open woods near Centerville, Princess Anne County.

IRIDACEAE.

Iris caroliniana S. Wats. Frequent on the marshy banks of streams: along Northwest River, May 11 (Nos. 1079, 1550); along North Landing River, May 22 (No. 1350).

Iris verna L. Sandy soil, in the open; near Suffolk, April 30 (No. 61 C. & K.); near Portsmouth, May 13.

Sisyrinchium atlanticum Bicknell. In sandy soil; near Portsmouth, May 13 (No. 1154); Munden Point, Princess Anne County, May 16 (No. 1181).

Sisyrinchium graminoides Bicknell. In open, moist ground; Northwest, Norfolk County, May 11 (No. 1087); near Suffolk, May 19 (No. 1239).

ORCHIDACEAE.

Cypripedium acaule Ait. Rich, shaded soil in "The Desert," Cape Henry, July 27 (No. 1837).

Habenaria blephariglottis (Willd.) Torr. In open bogs, Newbern, N. C., August 1 (Nos. 1938, 1979).

Habenaria clavellata (Michx.) Spreng. On an old stump in the Dismal Swamp, July 13 (No. 1648).

Habenaria cristata (Michx.) R. Br. Frequent in moist, usually shaded soil; near Suffolk, July 11 (No. 1575), July 18 (No. 1708); near Edenton, N. C., July 29 (No. 1890); near Newbern, N. C., August 1 (Nos. 1944, 1964).

Pogonia ophioglossoides (L.) Ker. Along Jericho Ditch, Dismal Swamp, July 12 (No. 1604), on hummocks among Sphagnum.

Gyrostachys cernua (L.) Kuntze. In marshy ground, Northwest, Norfolk County, November 8 (No. 2388).

Gyrostachys gracilis (Bigel.) Kuntze. Roadside, Suffolk, July 11 (No. 1573).

Gyrostachys odorata (Nutt.) Kuntze. In marshy ground along the Northwest River, July 9 (No. 1507).

Gyrostachys praecox (Walt.) Kuntze. Marshy ground, Northwest, July 9 (No. 1555).

Tipularia uniflora (Muhl.) B. S. P. In rich, moist woods: margin Lake Drummond, Dismal Swamp (No. 107 C. & K.); "The Desert," Cape Henry, July 27 (No. 1840).

Limodorum tuberosum L. In an open marsh, Northwest, July 9 (No. 1542)—small; in hummocks among Sphagnum and *Woodwardia virginica*, Dismal Swamp, July 12 (No. 1596)—very large, attaining a height of .9 meter (3 feet).

DICOTYLEDONES.

SAURURACEAE.

Saururus cernuus L. Common at the edges of swampy woods, especially in the Dismal Swamp (Nos. 1508, 1653).

JUGLANDACEAE.[1]

Juglans nigra L. Frequent at roadsides; in deciduous woods at the margin of a small lake near Suffolk (No. 1731).

Hicoria alba (L.) Britton. A rather common forest tree on the heavier but not swampy soils (Nos. 1247, 1421, 1526, 1736).

Hicoria glabra (Mill.) Britton. Frequent in woods, especially near streams (Nos. 1534, 1716, 1851).

Hicoria microcarpa (Nutt.) Britton. In deciduous woods near Suffolk (No. 1243.)

Hicoria villosa (Sarg.) Ashe. Summit of a bluff on Cohoon Creek, near Suffolk (No. 1728).

MYRICACEAE.[2]

Myrica carolinensis Mill. Abundant in pine woods and among the dunes (Nos. 57 C. & K., 1095, 1402, 1755, 1853).

Myrica cerifera L. Less common than the preceding, chiefly about ponds; near Virginia Beach, April 29 (No. 38 C. & K.). Both species are locally known as "myrtle."

SALICACEAE.[1]

Populus alba L. Naturalized in woodlands near dwellings, etc.; Ocean View (No. 1012).

Populus heterophylla L. Frequent at the edge of swampy woods along streams (Nos. 1098, 1341).

Salix fluviatilis Nutt. In marshy spots among the dunes, and also occasionally upon them, Cape Henry (No. 1388).

Salix humilis Marsh. Near Berkley, May 21 (No. 1313).

Salix nigra Marsh. Abundant in swampy woods along streams.

BETULACEAE.

Carpinus caroliniana Walt. Frequent in swampy woods, especially along streams.

Ostrya virginiana (Mill.) Willd. Bank of Long Creek, Lynnhaven Bay (No. 1859).

Alnus rugosa (Du Roi) Koch. Abundant, usually with *Salix nigra*.

FAGACEAE.[1]

Fagus americana Sweet. An abundant forest tree on moist, heavy soils.

Castanea pumila (L.) Mill. Frequent in dry woodlands, most abundant near Cape Henry and near Suffolk. (No. 34 C. & K.).

Quercus alba L. An abundant forest tree, especially on rather moist, clayey soils (Nos. 1055, 1068, 1073, 1132, 1171, 1529, 1594, 1722, 2217).

Quercus digitata (Marsh.) Sudworth. Abundant, especially in dry, sandy soil; frequent near the strand (Nos. 1009, 1134, 1144, 1186, 1210, 1220, 1533, 1570, 1723, 1841). Varies greatly in the form of its leaves.

Quercus heterophylla Michx. f. In dry pine woods: Northwest (No. 1115); Ocean View (No. 1437).

Quercus imbricaria Michx. In swampy woods: Northwest (No. 1094); Dismal Swamp (No. 1647).

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[1] Determined by Mr. G. B. Sudworth.
[2] Determined by Dr. John K. Small.

Quercus laurifolia Michx. In dry sandy soil: At top of a bluff on Cohoon Creek near Suffolk (Nos. 1720, 1721): innermost sand dunes near Cape Henry (Nos. 1829, 1830).

Quercus marylandica Muench. In sandy soil near Virginia Beach, April 29 (No. 53 C. & K.).

Quercus michauxii Nutt. A common forest tree in moist, heavy soil (Nos. 1051, 1063, 1090, 1139).

Quercus minor (Marsh.) Sarg. Common in rather dry, sandy soil, especially near streams (Nos. 1008, 1133, 1261, 1719, 1734, 1842, 1902).

Quercus nigra L. Very abundant in various soils, usually as low undergrowth in well-drained, sandy places but becoming a large tree in clayey, moist soils (Nos. 31 C. & K., 1065, 1067, 1092, 1127, 1156, 1197).

Quercus phellos L. Abundant, especially in low, moist ground, often planted as a shade tree (Nos. 1066, 1187, 1635). Locally known as "water oak."

Quercus rubra L. At water's edge on Cohoon Creek, near Suffolk (No. 1714).

Quercus velutina Lam. Usually in dry, sandy soil, frequent on the inner sand dunes (Nos. 1039, 1052, 1120, 1121, 1131, 1136, 1138, 1245, 1246, 1451, 1862, 2016).

Quercus virginiana Mill. On and among the inner dunes, Ocean View to Cape Henry (Nos. 1215, 1224, 1450, 1754), the last young plants with much-thickened roots.

Quercus alba x minor. In low woods near Cape Henry (No. 1858).

ULMACEAE.

Ulmus alata Michx. Roadside near Suffolk (No. 96 C. & K.).

Ulmus americana L. Frequent in low woods, especially along streams.

Celtis occidentalis L. Low, moist ground, Munden Point (No. 1192). Locally known as "skin and bones," from the nature of its fruit.

Celtis pumila Pursh. In dry, sandy woods, Ocean View (No. 1011); near Suffolk (No. 1252).

MORACEAE.

Morus rubra L. Frequent in mixed woods, usually as undergrowth (Nos. 1119, 1495).

Broussonetia papyrifera (L.) Vent. Naturalized on roadsides, Edenton, N. C. Frequently planted as a shade tree.

URTICACEAE.

Urticastrum divaricatum (L.) Kuntze. Rich low woods, Munden Point.

Boehmeria cylindrica (L.) Willd. Frequent along streams; abundant in the higher parts of the Dismal Swamp (No. 1760).

LORANTHACEAE.

Phoradendron flavescens (Pursh) Nutt. Abundant in the wooded swamps, upon *Acer rubrum* L. and *Nyssa biflora* Walt. (No. 2356).

SANTALACEAE.

Comandra umbellata (L.) Nutt. Dry woodland near Suffolk, April 30 (No. 50 C. & K.).

ARISTOLOCHIACEAE.

Asarum virginicum L. In rather low, open woods near Suffolk, April 30 (No. 56 C. & K.); low pine woods near Newbern, N. C., October 10.

Aristolochia serpentaria L. In dry upland woods near Suffolk (No. 1242); in open pine woods, Northwest (No. 1075): a form approaching *A. nashii* Kearney.

POLYGONACEAE.

Rumex acetosella L. An abundant weed in fields and roadsides, introduced (No. 1290).

Rumex conglomeratus Murr. Abundantly naturalized, in ditches (Nos. 1208, 1429, 1528).

Rumex crispus L. A common weed at roadsides and in neglected fields, introduced (No. 1280).

Rumex obtusifolius L. A common introduced weed (No. 1196).

Rumex verticillatus L. In marshy ground along a streamlet, Ocean View, May (Nos. 1216, 1434).

Fagopyrum fagopyrum (L.) Karst. In an old field near Norfolk, in which it was perhaps formerly cultivated (No. 1278).

Polygonum arifolium L. Very abundant in rich woods on the eastern margin of Lake Drummond, Dismal Swamp.

Polygonum aviculare L. Roadsides, etc., introduced (No. 1688).

Polygonum convolvulus L. In fields and at waysides, introduced (Nos. 1284, 1747).

Polygonum hydropiperoides Michx. Common in fresh-water river marshes and in pools in the Dismal Swamp (Nos. 1549, 1634, 1729, 2032, 2141).

Polygonum pennsylvanicum L. Abundant in old fields and on roadsides (No. 2166).

Polygonum persicaria L. A common naturalized weed (No. 1746).

Polygonum punctatum Ell. In rich, swampy woods, eastern margin of Lake Drummond (No. 2362).

Polygonum punctatum robustius Small. In marshy ground at roadside near Newbern, N. C., Oct. 10 (No. 2210).

Polygonum sagittatum L. Frequent in marshes.

Polygonum setaceum Baldw. In a low, grassy meadow near Newbern, N. C. Oct. 10 (No. 2246).

Polygonum virginianum L. In moist, low woodlands, frequent in Princess Anne County (No. 2183).

CHENOPODIACEAE.

Chenopodium album L. A common naturalized weed in waste and cultivated land (No. 1285).

Chenopodium ambrosioides L. Fields and roadsides, common, introduced (No. 2370).

Chenopodium anthelminticum L. A naturalized weed, frequent in waste ground; occasional on the sand strand.

Atriplex hastata L. At the border of salt marshes (No. 1022); in waste ground near Berkley (No. 1295).

Salsola kali L. Abundant on the beach and outer dunes, Ocean View to Virginia Beach (Nos. 1816, 2133).

PHYTOLACCACEAE.

Phytolacca decandra L. Frequent, especially in clearings in dry woodlands (No. 1802).

AIZOACEAE.

Mollugo verticillata L. Frequent in sandy fields and on the sand strand (Nos. 1929, 2125).

ALSINACEAE.

Agrostemma githago L. Along railways, Suffolk, introduced, May 19 (No. 1230).

Silene antirrhina L. Along railways near Suffolk, May 19 (No. 1268).

Saponaria officinalis L. Along railway tracks. Berkley, July 18.

Alsine media L. A common weed in fields and waste ground, introduced (Nos. 10 C. & K., 1293).

Cerastium viscosum L. Grassy places near Virginia Beach, introduced, April 29 (No. 11 C. & K.).

Cerastium vulgatum L. Sandy fields, introduced, May (No. 1145).

Sagina decumbens (Ell.) Torr. & Gr. Roadsides (No. 1137); common in crevices in the sidewalks of Norfolk, in the shade (No. 1195).

Sagina decumbens smithii (A. Gray) S. Wats. In a sandy field, Portsmouth, May 27 (No. 1376).

Ammodenia peploides (L.) Rupr. Beach at Cape Henry, scarce (No. 2132). An unusually slender and small-leaved form.

NYMPHAEACEAE.

Nymphaea advena Soland. Frequent in pools and fresh-water marshes (Nos. 1464, 1611).

Castalia odorata (Dryand.) Woodv. & Wood. Common in ponds and in ditches near the margin of the Dismal Swamp (No. 1081).

Nelumbo lutea (Willd.) Pers. Abundant in a shallow fresh-water bayou of Albemarle Sound, Edenton, N. C., July 29 (No. 1923).

RANUNCULACEAE.

Clematis crispa L. Common in the more open parts of the wooded swamps and in the partially timbered belt of the river marshes, May to July (Nos. 1348, 1503, 1643, 2005).

Ranunculus bulbosus L. An abundant, introduced weed in fields and on roadsides, May (No. 47 C. & K.).

Ranunculus parviflorus L. Grassy places near Virginia Beach, introduced, April 29 (No. 15 C. & K.).

Ranunculus recurvatus Poir. Rich, moist woods, Munden Point, May 16 (No. 1193).

Ranunculus sceleratus L. In a ditch at Deep Creek, May 17.

Thalictrum purpurascens L. Woods near Virginia Beach, May 29 (No. 1412).

BERBERIDACEAE.

Podophyllum peltatum L. Moist, rich woods, Virginia Beach.

MAGNOLIACEAE.

Magnolia virginiana L. An abundant small tree of the wooded swamps, May (Nos. 79 C. & K., 1605). This and Persea are known in the region as "bay."

Liriodendron tulipifera L. A common but rarely abundant forest tree on moist, heavy soils (No. 1804).

ANONACEAE.

Asimina triloba (L.) Dunal. Near Lake Drummond, Dismal Swamp, not frequent (No. 1649). Known locally by the odd name of "possum-pocket apples."

LAURACEAE

Persea pubescens (Pursh) Sarg. Common in woods, especially swampy woods (Nos. 104 C. & K., 1124, 1130, 1603, 2350). Popularly confused with *Magnolia virginiana*, under the name of "bay."

Sassafras sassafras (L.) Karst. Common in Virginia in dry soil, roadsides, fields, and edges of woods; Newbern, N. C. (No. 2188).

Benzoin benzoin (L.) Coulter. Banks of a small lake near Suffolk.

PAPAVERACEAE.

Sanguinaria canadensis L. Rich, shaded ground near Suffolk (No. 1241).

BRASSICACEAE.

Lepidium virginicum L. A common weed in fields and roadsides (Nos. 1270, 1404).

Coronopus didymus (L.) J. E. Smith. Abundantly naturalized in waste and cultivated land.

Sisymbrium officinale (L.) Scop. A common roadside weed, introduced (No. 1288).

Cakile edentula (Bigel.) Hook. Abundant on the beach and outer sand dunes, Ocean View to Virginia Beach (Nos. 1225, 1448).

Brassica campestris L. In old fields, introduced (No. 1302).

Raphanus raphanistrum L. In an old field near Norfolk, introduced, May 20 (No. 1275).

Cardamine arenicola Britton. In moist sand, near Kempsville, May 9 (No. 1040); near Pungo, May 14 (No. 1164).

SARRACENIACEAE.

Sarracenia flava L. In a bog in the pine woods near Newbern, N. C. (No. 2196).

DROSERACEAE.

Drosera intermedia Hayne. In a small marsh among the sand dunes, Cape Henry, July 26 (No. 1824).

SAXIFRAGACEAE.

Decumaria barbara L. Common in the Black Gum Swamp, near Lake Drummond, Dismal Swamp (No. 69 C. & K.); Edenton, N. C.

Itea virginica L. Abundant in the wooded swamps and along streams, May 25 (Nos. 94 C. & K., 1327, 1530).

HAMAMELIDACEAE.

Hamamelis virginiana L. Frequent in low woods (No. 28 C. & K.).

Liquidambar styraciflua L. A very abundant forest tree, especially on moist, heavy soils (Nos. 1800, 2371).

PLATANACEAE.

Platanus occidentalis L. Frequent along streams; often planted as a shade tree.

ROSACEAE.

Spiraea tomentosa L. In a low, marshy field, Edenton, N. C., July 28 (No. 1879); open, fresh-water marshes of the Pasquotank River, Elizabeth City, N. C. (No. 2007).

Rubus[1] argutus Link (*R. frondosus* Bigel). Along a ditch at roadside near Pungo, May 14 (No. 1161)—approaches var. *floridus;* on hummocks in the deep black-gum forest, Dismal Swamp (No. 1645)—a variety.

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[1] Rubus determined by Prof. L. H. Bailey.

Rubus cuneifolius Pursh. Common in dry sandy soil, fields and roadsides, May (Nos. 1165, 1212, 1366, 1395, 1586).

Rubus hispidus L. In moist, low ground, usually in woods (Nos. 1061, 1309, 1430, 1659).

Rubus trivialis Michx. In sandy fields and roadsides, Newbern, N. C. (No. 1965).

Rubus villosus Ait. (*R. canadensis* of authors, not of L.). In dry fields, common (Nos. 1057, 1177); on the open dunes, Virginia Beach (No. 22 C. & K.) (probably an outlying form).

Rubus nigrobaccus Bailey.[1] In a low field near Portsmouth, May 27 (No. 1365).

Fragaria virginiana Duchesne. Grassy roadside in pine woods, Ocean View, (No. 1443).

Fragaria virginiana australis Rydberg, var. nov. In low pine woods near Virginia Beach, April 29 (No. 16 C. & K.); along a railway near Suffolk (No. 1236).

Duchesnea indica (Andr.) Focke. At roadsides, near Norfolk; introduced (No. 1023).

Potentilla canadensis L. Roadsides near Suffolk, April 29 (No. 48 C. & K.).

Potentilla monspeliensis L. On comparatively high ground in a clearing, margin of Lake Drummond, Dismal Swamp, July 14 (No. 1665).

Potentilla pumila Poir.[2] Among grasses in dry sandy soil in woods of *Pinus echinata* near Suffolk, May 17 (No. 1235).

Geum canadense Jacq. In rich low woods, Northwest, July 9 (No. 1500).

Agrimonia parviflora Soland. Along a ditch in a field, Newbern, N. C., October 10 (No. 2233).

Agrimonia striata Michx. In rich low woods, near Suffolk, July 18 (No. 1738); near Virginia Beach, October 2 (No. 2071).

Rosa carolina L. Common in swamps and along ditches (Nos. 18 C. & K., 1118, 1458).

Rosa humilis Marsh. In a field near Portsmouth (No. 1362).

Rosa rubiginosa L. With the preceding; introduced (No. 1361).

PYRACEAE.

Malus angustifolia (Ait.) Michx. In swampy ground, especially along streams, frequent, April 29 (Nos. 8 C. & K., 1428).

Aronia arbutifolia (L.) Ell. Common in moist woods and the edges of wooded swamps (Nos. 92 C. & K., 1128, 1601, 2345).

Aronia nigra (Willd.) Britton. In low ground, Virginia Beach (No. 3 C. & K.); Suffolk (No. 59 C. & K.).

Amelanchier botryapium (L. f.) DC. Common in low woods and swamps (Nos. 51, 52, 81, 112 C. & K., 1100, 1125, 1173, 1259). Local name "wild currants."

Crataegus coccinea L. In swampy woods near Kempsville (No. 1047); a small form with small leaves.

Crataegus crus-galli L. Dry soil in the open, Ocean View (No. 1484).

Crataegus uniflora Muench. In dry, open woods near Edenton, N. C., (No. 1903).

AMYGDALACEAE.

Prunus americana Marsh. At water's edge on Cohoon Creek, near Suffolk (No. 1698).

Prunus angustifolia Marsh. Dry soil in fields and on roadsides, common, often forming small thickets (Nos. 80 C. & K., 1072).

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[1] *R. nigrobaccus* is the *R. villosus* of authors, not of Aiton.

[2] Determined by Mr. P. A. Rydberg.

Prunus cerasus L. A single tree in woods near Lynnhaven Station (No. 1122); adventive.

Prunus serotina Ehrh. Frequent, especially along streams (Nos. 1071, 1126); on the inner sand dunes, Ocean View to Cape Henry (Nos. 1209, 1396); a form with thickish leaves, as in var. *smallii* Britton.

MIMOSACEAE.

Albizzia julibrissin Duraz. Naturalized at roadsides and in open fields near the town, Edenton, N. C., July 28 (No. 1895).

CASSIACEAE.

Cercis canadensis L. On the wooded bank of a small lake near Suffolk (No. 1249).

Senna marilandica (L.) Roadsides near Virginia Beach.

Chamaecrista[1] aspera (Muhl.) Greene. Sandy roadsides, Newbern, N. C. (No. 2226).

Chamaecrista fascicularis Michx. Roadside near Virginia Beach, October 6 (No. 3136); in shallow water, marshy bank of the Trent River, Newbern, N. C., October 10 (No. 2218), growing with *Coreopsis gladiata* and *Centella asiatica*.

Chamaecrista nictitans (L.) Greene. In rather moist sandy soil, bordering a brackish meadow, Virginia Beach, August 4 (No. 2034).

VICIACEAE.

Baptisia tinctoria (L.) R. Br. In dry sandy soil, chiefly in pine woods, Lynnhaven Station; Edenton, N. C. (No. 1891).

Crotalaria purshii DC. In dry, open pine woods, Edenton, N. C., July 29 (No. 1905).

Medicago lupulina L. Introduced; common in fields and roadsides near Norfolk (No. 1294).

Trifolium arvense L. Dry sandy fields, introduced, Norfolk, May 20 (No. 1282).

Trifolium dubium Sibth. Roadsides, West Norfolk, introduced, May 10 (No. 1074).

Trifolium hybridum L. Roadsides near Norfolk, introduced, May (No. 1027).

Trifolium pratense L. Common, naturalized in fields and roadsides, May (No. 1301).

Trifolium procumbens L. Fields and roadsides, introduced, May; near Berkley (No. 1320); near Norfolk (No. 1277); a small form approaching *T. dubium*.

Trifolium repens L. Abundantly naturalized in fields and roadsides, May (No. 1298).

Psoralea pedunculata (Mill.) Vail. Sandy roadside near Edenton, N. C., July 29 (No. 1893).

Indigofera caroliniana Walt. In dry sandy soil, fields and edges of thickets, Newbern, N. C., August 1 (No. 1958).

Cracca spicata (Walt.) Kuntze. In dry sandy soil; Suffolk, July 11 (No. 1588); Edenton, N. C., July 29 (No. 1904).

Robinia pseudacacia L. In a thicket behind the dunes, Ocean View, May 18 (No. 1213); shore of Lynnhaven Bay.

Stylosanthes biflora (L.) B. S. P. Sandy soil along railways; Northwest, July 9 (No. 1489); Edenton, N. C., July 29 (No. 1869); a form approaching *S. riparia*.

Stylosanthes riparia Kearney. Sandy soil along railway near Suffolk, July 15 (No. 1684); prophyllum not lobed.

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[1] Chamaecrista determined by Mr. C. L. Pollard.

Zornia bracteata (Walt.) Gmel. Dry sandy roadsides, common, Newbern, N. C., August 1 (Nos. 1927, 1990).

Meibomia arenicola Vail. On the innermost sand dunes and in the flat pine woods behind them. Virginia Beach, October 3 (Nos. 2020, 2068).

Meibomia dillenii (Darl.) Kuntze. In dry pine woods, Edenton, N. C.

Meibomia marylandica (L.) Kuntze. With the preceding.

Meibomia nudiflora (L.) Kuntze. Low pine woods near Berkley, July 19 (No. 1742).

Meibomia obtusa (Muhl.) Vail. Roadsides, Newbern, N. C., October 10 (No. 2230).

Meibomia paniculata chapmani Britton. Low pine woods, Virginia Beach, August 3 (No. 2014).

Meibomia rigida (Ell.) Kuntze. Roadsides through pine woods, Virginia Beach, October 6 (No. 2144).

Meibomia stricta (Pursh) Kuntze. In an open pine wood, among grasses, Edenton, N. C., July 29 (No. 1884).

Meibomia viridiflora (L.) Kuntze. On the innermost pine-wooded sand dunes. Ocean View.

Meibomia sp. An apparently undescribed form with much the habit and foliage of *M. paniculata pubens*, but with the loment joints more rounded.

Lespedeza capitata Michx. Dry sandy roadsides, Newbern, N. C., October 10 (Nos. 2224, 2228).

Lespedeza procumbens Michx. In dry sandy soil, roadsides, and open pine woods, Northwest, July 9 (No. 1490); Virginia Beach, October 2 (No. 2096).

Lespedeza striata (Thunb.) Hook. & Arn. Frequent in dry sandy soil at roadsides, introduced (No. 2138).

Lespedeza stuvei neglecta Britton. Dry sandy roadsides, Newbern, N. C., October 10 (No. 2215).

Lespedeza virginica (L.) Britton. Dry sandy fields and borders of woods, Virginia Beach (No. 2100).

Vicia angustifolia Roth. Abundantly naturalized in fields and on roadsides, May (Nos. 75 C. & K., 1015).

Vicia hirsuta (L.) Koch. Abundant in dry sandy soil, fields, and roadsides, naturalized, May (No. 1014).

Vicia sativa L. Abundantly naturalized, fields and roadsides, May (Nos. 6 C. & K., 1030, 1323).

Bradburya virginiana (L.) Kuntze. Dry sandy soil, fields and roadsides, frequent, July (Nos. 1587, 1989, 2189).

Clitoria mariana L. Sandy soil at roadsides, Northwest, July 9 (No. 1528).

Falcata comosa (L.) Kuntze. In low, moist pine woods, Ocean View (No. 2395).

Apios apios (L.) MacM. Frequent in shaded, swampy ground (Nos. 1595, 2847). Known locally as "wild potato."

Galactia[1] **regularis** (L.) B. S. P. In dry sandy woods of *Pinus taeda*, Cape Henry, July 27 (No. 1831).

Galactia volubilis (L.) Britton. Abundant in dry sandy soil, roadsides, grassy fields, and pine woods (Nos. 1520, 1901, 1934, 2197). Exceedingly variable, especially in leaf form. No. 1934 has narrow, linear leaflets. No. 2197, collected at Newbern, N. C., has subcoriaceous leaflets with a shining upper surface, resembling those of *Galactia regularis*.

Rhynchosia tomentosa (L.) Hook. & Arn. In dry, sandy fields: Suffolk, July 11 (No. 1589); Newbern, N. C., October 10 (No. 1957).

Strophostyles helvola (L.) Ell. Among the outer sand dunes, Cape Henry, October 5 (No. 2135).

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[1] Galactia determined by Miss A. M. Vail.

Strophostyles umbellata (Muhl.) Britton. In dry sandy soil, fields, and roadsides (Nos. 1935, 2036).

GERANIACEAE.

Geranium carolinianum L. Roadside, Lambert Point, May 27 (No. 1021).

OXALIDACEAE.

Oxalis cymosa Small. Roadsides, etc., common (Nos. 1167, 1319, 1417).
Oxalis filipes Small. In open woodland, Suffolk, May 19 (No. 1266).
Oxalis recurva Ell. Sandy roadside, Ocean View, May 6 (No. 1016).
Oxalis stricta L. Roadsides, Suffolk, April 30 (No. 45 C. & K.).
Oxalis violacea L. Sandy field, Lynnhaven Station, May 13 (No. 1143).

LINACEAE.

Linum floridanum (Planch.) Trelease. Grassy roadside, Suffolk, July 11 (No. 1569); sandy field, Newbern, N. C., August 1 (No. 1978).
Linum medium (Planch.) Britton. In sandy fields, roadsides, etc., frequent, Cape Henry and Suffolk to Edenton, N. C. (Nos. 1492, 1569a, 1823, 1898, 2015).
Linum striatum Walt. In shade along a roadside ditch, Northwest, July 9 (No. 1527).
Linum virginianum L. (?) Shaded roadside, Virginia Beach, October 6 (No. 2140). Habit and spreading leaves of *L. virginianum*, but the capsule ovoid, pointed.

RUTACEAE.

Zanthoxylum clava-herculis L. Common on the innermost wooded sand dunes and in the pine woods behind them (No. 1767).

SIMARUBACEAE.

Ailanthus glandulosa Desf. Naturalized on bluffs along Nansemond River near Suffolk.

MELIACEAE.

Melia azedarach L. Roadside at Wallaceton, perhaps planted (No. 1805).

POLYGALACEAE.

Polygala incarnata L. Sandy fields, Northwest, July 9 (No. 1493); Suffolk, July 11 (No. ——).
Polygala lutea L. Boggy places, Newbern, N. C., July 31 (No. 1941).
Polygala mariana Mill. Open, sandy ground at waysides, Suffolk, July 11 (No. 1577); Edenton, N. C. (No. 1865).
Polygala verticillata L. Roadside, Suffolk, July 11 (No. 1568).

EUPHORBIACEAE.

Phyllanthus carolinensis Walt. In a low, sandy field, Edenton, N. C., July 29 (No. 1881).
Croton glandulosus L. Dry sandy waysides, Berkley; Newbern, N. C., July 31 (No. 1924).
Acalypha gracilens A. Gray. In a low field, Newbern, N. C., July 31 (No. 1926), not glandular; dry, sandy roadside, Virginia Beach, October 3 (No. 2103), sparingly glandular.

Tragia urens L. Dry sandy soil in open pine woods, Lynnhaven Bay (No. 2115).

Jatropha stimulosa Michx. Sandy soil, fields, and open pine woods, Ocean View, May 18 (No. 1222); near Suffolk, July 18 (No. 1727); Lynnhaven Bay.

Euphorbia ipecacuanhae L. Sandy soil in open woods, near Suffolk, July 18.

Euphorbia maculata L. Along railway, Edenton, N. C., July 29 (No. 1864).

Euphorbia nutans Lag. Roadside near Virginia Beach, October 3 (No. 2108).

Euphorbia polygonifolia L. Among the outer sand dunes, common, Ocean View to Virginia Beach (Nos. 1812, 2062).

CALLITRICHACEAE.

Callitriche heterophylla Pursh. In shallow ponds, common (Nos. 1109, 1256, 1257).

ANACARDIACEAE.

Rhus copallina L. Common in dry soil, fields, fence rows, open woods, etc. (Nos. 1150, 1683, 2372).

Rhus glabra L. Near Suffolk.

Rhus radicans L. Common, especially in low woods (Nos. 1026, 1123, 1759). Local name, "cow itch."

Rhus toxicodendron L. In dry woodlands, near Cape Henry (No. 1863); near Kempsville, Princess Anne County (No. 2165).

Rhus vernix L. Frequent in the more open parts of the wooded swamps. Known locally as "boar wood."

CYRILLACEAE.

Cyrilla racemiflora Walt. In a small swamp along a brook, Newbern, N. C.

ILICACEAE.

Ilex caroliniana (Walt.) Trelease. In dry sandy soil in copses near the Trent River, Newbern, N. C. (No. 2214).*

Ilex decidua Walt. Frequent in the Dismal Swamp (No 1667): at water's edge along Cohoon Creek above Suffolk (No. 1700).

Ilex glabra (L.) A. Gray. Common, especially in low pine woods (Nos. 1297, 2385).

Ilex lucida (Ait.) Torr. & Gr. Frequent about Lake Drummond (Nos. 95 and 106 C. & K., 1657, 1661).

Ilex opaca Ait. Common, especially in rather moist woods, May (Nos. 1117, 1188).

Ilex verticillata (L.) A. Gray. In the *Nyssa biflora* forest near Lake Drummond, Dismal Swamp, not common (No. 1644).

CELASTRACEAE.

Euonymus americanus L. Frequent in low woods and wooded swamps (Nos. 105 C. & K., 1347, 2102).

ACERACEAE.

Acer rubrum L. In low woods and wooded swamps, one of the most abundant trees of the region (No. 1637); in clearings about Lake Drummond, Dismal Swamp, occurs a form (No. 1660) with leaves less sharply lobed and white and somewhat pubescent on the under surface, which may be *A. drummondii* Hook. & Arn.

IMPATIENTACEAE.

Impatiens biflora Walt. Shaded soil on Lake Drummond, Dismal Swamp.

RHAMNACEAE.

Berchemia scandens (Hill) Trelease. Common in the wooded swamps, May (Nos. 1362, 1504). Locally known as "rattan."

Ceanothus americanus L. In low pine woods near Portsmouth.

VITACEAE.

Vitis aestivalis Michx. Common in dry pine woods, especially near the strand (Nos. 1318, 1769, 1777).

Vitis cordifolia Michx. In low woods, Northwest (No. 1502), near Suffolk (1707).

Vitis labrusca L. In swampy woods, Dismal Swamp (No. 1650), near Elizabeth City, N. C. (No. 2004).

Vitis rotundifolia Michx. In woods and among the inner sand dunes, very abundant (Nos. 39 and 103 C. & K., 1364, 1784).

Ampelopsis arborea (L.) Rusby. In a swamp near Newbern, N. C., August 1 (No. 1946).

Parthenocissus quinquefolia (L.) Planch. Abundant in woods (No. 1669).

MALVACEAE.

Sida spinosa L. An abundant weed in cornfields. Wallaceton (No. 2332).

Malva rotundifolia L. About wharves, Suffolk, introduced July 18.

Kosteletzkya virginica (L.) A. Gray. Salt marshes near Virginia Beach (No. 2120); edge of a marsh near Newbern, N. C. (No. 1925).

Hibiscus moscheutos L. Common at the edge of salt marshes (Nos. 1354, 1765). Local name "wild cotton."

HYPERICACEAE.

Ascyrum hypericoides L. Dry, sandy soil, open pine woods, roadsides, etc. (Nos. 1056, 1799, 2179).

Ascyrum hypericoides angustifolium (Nutt.) (*A. crux-andreae angustifolium* Nutt.). Dry, sandy roadside, Newbern, N. C. (No. 2205).

Ascyrum stans Michx. Low ground along ditches, etc., Suffolk (No. 1227); Edenton, N. C.; July 29 (No. 1888).

Hypericum galioides Lam. In moist, open ground near Newbern, N. C.; August 1 (Nos. 1932, 1933).

Hypericum mutilum L. Marshy ground on Lake Drummond; July 14 (No. 1651).

Hypericum perforatum L. At a roadside near Norfolk, introduced July 16 (No. 1686).

Hypericum pilosum Walt. Dry sandy fields near Newbern, N. C., August 1 (No. 1967).

Hypericum virgatum Lam. Frequent in sandy fields (Nos. 1953, 1982, 2048).

Sarothra gentianoides L. In moist sand about pools among the sand dunes, Ocean View (No. 1773); Virginia Beach (No. 2056).

Triadenum petiolatum (Walt.) Britton. In shady places along Washington Ditch, Dismal Swamp, July 13 (No. 1646).

Triadenum virginicum (L.) Raf. In the Dismal Swamp along Jericho Ditch (No. 1597); in a marsh near Newbern, N. C. (No. 2241).

CISTACEAE.

Helianthemum canadense (L.) Michx. In dry sandy soil among pines inside the sand dunes, Ocean View to Cape Henry, May (Nos. 1223, 1758, 2116).

Hudsonia tomentosa Nutt. Abundant among the sand dunes, Ocean View to Virginia Beach (Nos. 42 C. & K., 1000, 1398).

Lechea leggettii Britton & Hollick. Dry sandy soil, Edenton, N. C. (No. 1885): Newbern, N. C. (No. 1943); Virginia Beach (No. 2041).

Lechea maritima Leggett. Abundant among the sand dunes, Ocean View to Virginia Beach (Nos. 1001, 1387, 2094).

Lechea minor L. Dry sandy soil, fields and roadsides, Newbern, N. C. (Nos. 1966, 2204).

Lechea racemulosa Michx. In dry soil, roadside, Suffolk, July 11 (No. 1584).

Lechea villosa Ell. In dry sandy soil, edge of pine woods near Virginia Beach, August 4 (No. 2040).

VIOLACEAE.

Viola asarifolia Pursh. Edge of pine woods, Northwest (No. 1499).

Viola brittoniana Pollard. In low pine woods, Munden Point, Princess Anne County, May 16 (No. 1130).

Viola emarginata (Nutt.) Le Conte. Roadside through woods, Northwest, May 11 (No. 1112): sandy soil, edge of pine woods, Portsmouth, May 27 (Nos. 1363, 1377).

Viola lanceolata L. Moist sandy soil, Virginia Beach, April 29 (No. 2 C. & K.); Pungo, Princess Anne County, May 14 (No. 1187).

Viola pedata L. Sandy soil along railway, Suffolk, April 30 (No. 68 C. & K.).

Viola primulaefolia L. Frequent in moist sandy ground, May (Nos. 1045, 2339).

Viola sororia Willd. (?) Roadside, Berkley, May 21 (No. 1325).

Viola sp. In low grassy places near Virginia Beach, April 29 (No. 14 C. & K.); a probably undescribed species, according to Dr. E. L. Greene.

PASSIFLORACEAE.

Passiflora incarnata L. Roadsides and railway embankments, July (No. 1535).

Passiflora lutea L. Pine woods behind the dunes, Ocean View (No. 1217).

CACTACEAE.

Opuntia opuntia (L.) Coulter. Frequent along Lynnhaven Bay and in pine woods behind the dunes at Virginia Beach (No. 1384).

LYTHRACEAE.

Rotala ramosior (L.) Koehne. Frequent in marshy places (Nos. 1912, 2090). Specimens 35 cm. (14 inches) high were collected at Edenton.

Decodon verticillatus (L.) Ell. Frequent in open places in, and at the edges of, wooded swamps (No. 1524).

Lythrum lineare L. Frequent in salt marshes, Virginia Beach, August 3 (Nos. 2013, 2015).

MELASTOMACEAE.

Rhexia ciliosa Michx. Common in boggy places, Newbern, N. C., August 1 (Nos. 1939, 1983, 2195).

Rhexia glabella Michx. In open bogs near Newbern, N. C., August 1 (No. 1986).

Rhexia mariana L. Common in open marshes (Nos. 1619, 1620, 1877, 1878, 1882, 1956, 2047, 2234). In all but the first two numbers, the petals are distinctly aristate.

Rhexia virginica L. Common in marshy places (Nos. 1563, 1621, 1910, 2335); in the last number the leaves are short-petioled.

ONAGRACEAE.

Isnardia palustris L. Common in moist, low ground and in shallow pools (Nos. 1553, 2163).

Ludwigia alata Ell. In a bog, Newbern, N. C., August 1 (No. 1961).

Ludwigia alternifolia L. In open places in the Dismal Swamp, July 14 (No. 1666).

Ludwigia glandulosa Walt. Along a ditch at roadside, Edenton, N. C., July 30 (No. 1921).

Ludwigia linearis Walt. Frequent in ditches and marshes, Newbern, N. C. (No. 2243); Wallaceton (No. 2336).

Ludwigia pilosa Walt. In a bog, Newbern, N. C. (No. 1954).

Ludwigia virgata Michx. Dry sandy fields, Newbern, N. C., August 1 (Nos. 1931, 1981).

Jussiaea decurrens (Walt.) DC. In marshy ground along the Dismal Swamp Canal, Wallaceton (No. 2353).

Onagra biennis (L.) Scop. Roadsides.

Oenothera humifusa Nutt. Abundant among the dunes, Ocean View to Virginia Beach (Nos. 43 C. & K., 1389, 1452, 1808).

Oenothera laciniata Hill. Frequent in sandy fields and roadsides near Norfolk, May (Nos. 1013, 1024).

Kneiffia longipedicellata Small. In fresh-water river marshes; along Northwest River, July 9 (No. 1515); along Pasquotank River (No. 1998).

Circaea lutetiana L. In rich, low woods, Ocean View, July 8 (No. 1468).

HALORAGIDACEAE.

Proserpinaca palustris L. Frequent in open, fresh-water marshes: Northwest, July 9 (No. 1548).

Proserpinaca pectinata Lam. With the preceding.

Myriophyllum heterophyllum Michx. Frequent in ponds: Ocean View, July 8 (No. 1455); Duck Pond, Dismal Swamp, July 13.

ARALIACEAE.

Aralia spinosa L. Common in dry pine woods, abundant inside the dunes (No. 2176.)

APIACEAE.[1]

Daucus carota L. Abundantly naturalized in fields and roadsides (No. 1433).

Eryngium virginianum Lam. In fresh-water river marshes: Along the Pasquotank River, August 3 (No. 2008); along the Northwest River (No. 2380).

Sanicula canadensis L. In fertile soil, open pine woods, Ocean View (No. 1470).

Foeniculum foeniculum (L.) Karst. Frequent at roadsides and about dwellings, naturalized (No. 1571).

Sium cicutaefolium Gmel. Common in fresh-water river marshes (No. 1730).

Cicuta maculata L. Frequent in marshes, especially at the edge of swampy woods (No. 2357).

Ptilimnium capillaceum (Michx.) Holl. In moist ground at roadsides: Northwest, July 9 (No. 1564); Edenton, N. C., July 30 (No. 1911).

Ptilimnium sp. nov.? Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1705); immature.

Hydrocotyle ranunculoides L. f. In marshy places at roadside, Edenton, N. C. (No. 1908).

Hydrocotyle umbellata L. Common in moist, sandy soil (Nos. 1556, 1827, 1907).

Hydrocotyle verticillata L. In moist, sandy soil, Virginia Beach (No. 1383).

Centella asiatica (L.) Urban. Common in moist, sandy soil (Nos. 24 C. & K., 1382).

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[1] Determined with the assistance of Dr. J. N. Rose.

CORNACEAE.

Cornus[1] **candidissima** Marsh. Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1704).

Cornus florida L. Common in rather dry woodland (Nos. 7 C. & K., 1116).

Cornus stricta Lam. Swampy woods near northwest (No. 1110).

Nyssa[2] **aquatica** L. Abundant in the larger wooded swamps (Nos. 111 and 114 C. & K., 1111, 1340, 1353, 1615). Known locally as "papaw gum."

Nyssa biflora Walt. The most abundant tree of the wooded swamps (Nos. 109 C. & K., 1108, 1345, 1599, 1679, 1712, 1792.) Local designations "gum" and "black gum."

Nyssa sylvatica Marsh. Common in nonpalustrine woods (Nos. 1034, 1314, 1733).

CLETHRACEAE.

Clethra alnifolia L. Abundant in swamps (Nos. 30 C. & K., 1439, 1687).

PYROLACEAE.

Chimaphila maculata (L.) Pursh. In dry sandy pine woods inside the sand dunes, Virginia Beach (No. 2023).

Chimaphila umbellata (L.) Nutt. With the preceding (No. 2024).

MONOTROPACEAE.

Monotropa uniflora L. In low woods, Virginia Beach, Oct. 3 (No. 2076).

ERICACEAE.

Azalea canescens Michx. In open places in woodlands, frequent, May (Nos. 49 C. & K., 1062).

Azalea viscosa L. Common in wooded swamps, especially in the Dismal Swamp (Nos. 90 C. & K., 1042, 1440, 1532).

Kalmia angustifolia L. In the Dismal Swamp, along Jericho Ditch, not abundant (No. 91 C. & K.).

Kalmia latifolia L. In low woods: Deep Creek, May 17 (No. 1202); near Suffolk, May 19.

Leucothoë axillaris (Lam.) D. Don. Rather common in the Dismal Swamp, especially near Lake Drummond, May 2 (No. 76 C. & K.); Deep Creek, May 17.

Leucothoë racemosa (L.) A. Gray. Common in low woods and in the open parts of the wooded swamps, May (Nos. 78 and 102 C. & K., 1043, 1175, 1494).

Pieris mariana (L.) Benth. & Hook. Railway embankment near Suffolk, May 19 (No. 1226).

Pieris nitida (Bartr.) Benth. & Hook. Abundant in the more open parts of the Dismal Swamp (Nos. 85 C. & K., 1592). Known in the region as "hemlock," the popular name of *Leucothoë catesbaei* in the Alleghanies.

Xolisma[3] **foliosiflora** (Michx.) Small. Common in the more open parts of the wooded swamps, May (Nos. 83 C. & K., 1343, 1606, 1607, 1658).

Xolisma ligustrina (L.) Britton. Frequent in low woods (Nos. 1064, 1442); along Jericho Ditch, Dismal Swamp (No. 1607a), but there much less common than the preceding.

Oxydendrum arboreum (L.) DC. Common in open woodlands (Nos. 1069, 1578).

Epigaea repens L. Summit of a wooded bluff near Suffolk.

Gaultheria procumbens L. In a clearing on Lake Drummond, Dismal Swamp (No. 71 C. & K.).

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[1] Cornus determined by Dr. W. A. Evans.

[2] Nyssa determined by Mr. G. B. Sudworth.

[3] Xolisma determined by Dr. John K. Small.

VACCINIACEAE.

Gaylussacia frondosa (L.) Torr. & Gr. Common in woodlands, especially in open places (Nos. 1070, 1096, 1233, 1449, 1531).

Gaylussacia resinosa (Ait.) Torr. & Gr. In low, mixed woods behind the dunes, Virginia Beach, April 30 (No. 33 C. & K.); Cape Henry (No. 1834).

Vaccinium corymbosum L. Common in woodlands, especially in dry soil and rather open places (Nos. 37 and 77 C. & K., 1183, 1184, 1198, 1580).

Vaccinium vacillans Kalm. In dry woods, especially in open places, common (Nos. 32 C. & K., 1103, 1521, 1581).

Vaccinium virgatum tenellum (Ait.) A. Gray. Edge of upland pine woods near Suffolk, April 30 (Nos. 44, 54, and 60 C. & K., 1579).

Batodendron arboreum Nutt. Summit of a wooded bluff on Cohoon Creek near Suffolk (No. 1725). Apparently known in the region as "hackberry," the name usually applied to species of Celtis.

Polycodium stamineum (L.) Greene. Common in woods (Nos. 27 and 67 C. & K., 1093, 1833).

Oxycoccus macrocarpus (Ait.) Pers. Edge of a brackish meadow near Virginia Beach (No. 2042).

PRIMULACEAE.

Samolus floribundus H. B. K. Edge of a salt marsh, Great Bridge, May 26 (No. 1355).

Lysimachia angustifolia Michx. In a bog, Newbern, N. C. (No. 1955).

Lysimachia quadrifolia L. Sandy soil in open woods near Berkley, May 21 (No. 1305).

Lysimachia terrestris (L.) B. S. P. Moist sandy ground at edge of woods, northwest (No. 1562).

EBENACEAE.

Diospyros virginiana L. Abundant in dry soil in fields and thickets and on roadsides, and frequent on the inner dunes (No. 1407).

STYRACACEAE.

Styrax grandifolia Ait. A small shrub in low woods, scarce, Northwest (No. 1091); Pungo (No. 1170).

SYMPLOCACEAE.

Symplocos tinctoria (L.) L'Hér. Frequent, especially in low ground (Nos. 35 C. & K., 1166, 1172, 1201).

OLEACEAE.

Fraxinus caroliniana Mill.[1] Common in the wooded swamps (Nos. 1050, 1328, 1630, 1680).

Chionanthus virginica L. Swampy banks of Cohoon Creek near Suffolk (No. 1703).

LOGANIACEAE.

Gelsemium sempervirens L. Abundant in almost all formations except the salt and fresh water river marshes (Nos. 17 and 101 C. & K., 1168, 1997).

Cynoctonum sessilifolium (Walt.) Gmel. In a sedgy bog, Newbern, N. C., August 1 (No. 1962).

Polypremum procumbens L. Sandy roadside, Suffolk, July 11 (No. 1574).

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[1] Fraxinus determined by Mr. G. B. Sudworth.

GENTIANACEAE.[1]

Sabbatia angularis (L.) Pursh. Low ground, Northwest, July 9 (No. 1512).

Sabbatia calycina (Lam.) Heller. Shaded, swampy banks of streams, Suffolk (No. 1726); Edenton, N. C. (No. 1917).

Sabbatia dodecandra (L.) B. S. P. Fresh-water river marshes, Pasquotank River, near Elizabeth City, N. C., August 1 (No. 1996); Northwest River (No. 2377).

Sabbatia lanceolata (Walt.) Torr. & Gr. In open, boggy ground, Newbern, N. C., August 1 (No. 1945).

Sabbatia stellaris Pursh. In salt marshes on Lynnhaven Bay, July 27 (No. 1857).

Gentiana elliottii Chapm. Shaded woodsides through woodland, Virginia Beach, October 4 (No. 2137); Northwest, November 8 (No. 2384).

Bartonia virginica (L.) B. S. P. In marshy ground among pine woods, Edenton, N. C., July 29 (No. 1875).

APOCYNACEAE.

Vinca major L. About dwellings, Pungo, Princess Anne County, May 14 (No. 1155); escaped from gardens.

Apocynum cannabinum L. In open pine woods near Berkley.

Apocynum pubescens R. Br. In open pine woods, Ocean View, July 8 (No. 1472).

Trachelospermum difforme (Walt.) A. Gray. In a pine-barren bog, Edenton, N. C. (No. 1874).

ASCLEPIADACEAE.

Asclepias lanceolata Walt. In fresh-water river marshes, Northwest, July 9 (No. 1513); Elizabeth City, N. C., August 2 (No. 1992).

Asclepias pulchra Ehrh. In marshes, along Pasquotank River, Elizabeth City, August 2 (No. 2010); Wallaceton (No. 2340).

Asclepias variegata L. In dry pine woods, Suffolk, May 19 (No. 1262); Portsmouth, May 27 (No. 1368).

Vincetoxicum carolinense (Jacq.) Britton. In low pine woods, Virginia Beach, October 2 (No. 2072).

CONVOLVULACEAE.

Dichondra evolvulacea (L. f.) Britton. Railway embankment (probably introduced from farther south), Northwest (No. 2368).

Ipomoea hederacea Jacq. In cornfields, introduced, Wallaceton

Ipomoea pandurata (L.) Meyer. In sandy fields.

Ipomoea purpurea (L.) Roth. In fallow and cultivated lands, frequent, introduced (No. 2185).

Ipomoea quamoclit L. In a sandy field near Kempsville, Princess Anne County, introduced, October 7 (No. 2186).

Convolvulus americanus (Sims) Greene. Sloping bank of a pond inside the sand dunes, Virginia Beach (No. 2022).

Convolvulus repens L. Sandy field, Ocean View, May 30 (No. 1446).

CUSCUTACEAE.

Cuscuta arvensis Beyrich. In a sandy field, Suffolk, July 11 (No. 1583).

Cuscuta gronovii Willd. Frequent in the more open parts of the Dismal Swamp, on various plants (e. g., *Dianthera americana* L. and *Rubus nigrobaccus* Bailey).

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[1] Determined by Mr. C. L. Pollard.

BORAGINACEAE.

Cynoglossum virginicum L. In rich low woods near Suffolk, May 19 (No. 1228); Virginia Beach.

VERBENACEAE.

Verbena officinalis L. About wharves, Suffolk, introduced, July 18.

Verbena urticifolia L. Swampy woods along Cohoon Creek near Suffolk, July 18 (No. 1739).

Lippia sp. nov.? In brackish marshes near Virginia Beach, August 4 (No. 2033); nearly related to *L. lanceolata* Michx., but differs in the rather strict, negatively geotropic growth of the upper part of its stems, the erect, appressed, narrow leaves, usually purplish color of the whole plant, etc.

Callicarpa americana L. Common in low woods, especially near the strand (most abundant near Virginia Beach), (Nos. 1296, 1498, 2086).

NEPETACEAE.

Teucrium canadense L. In shady places near a spring, Lynnhaven Bay, July 27 (No. 1850).

Trichostema dichotomum L. In dry sandy soil, Virginia Beach, October 5.

Scutellaria integrifolia L. In the open, in moist, sandy soil, Portsmouth, May 27 (No. 1372).

Scutellaria lateriflora L. In swampy woods, margin of Lake Drummond, Dismal Swamp, abundant, July 14 (No. 1652).

Scutellaria pilosa Michx. In dry soil, open pine woods, Northwest (No. 1488).

Prunella vulgaris L. In low woods near Berkley, naturalized, May 21 (No. 1316).

Physostegia denticulata (Ait.) Britton. In marshy ground along railway, Elizabeth City, N. C., August 2 (No. 1999), small-flowered.

Lamium amplexicaule L. Naturalized in waste and cultivated land near Norfolk (No. 1286).

Salvia lyrata L. Dry, sandy soil, Northwest, May 11 (No. 1113).

Monarda punctata L. Frequent in dry, sandy soil, common at Cape Henry among the sand dunes (Nos. 1390, 1819, 1928, 2126).

Mesosphaerum rugosum (L.) Pollard. In moist ground, in the open, Newbern, N. C., July 31 (No. 1949).

Koellia hyssopifolia (Benth.) Britton. In dry, sandy soil, roadsides, and open pine woods: Edenton, N. C., July 29 (No. 1867); Newbern, N. C., August 1 (No. 1971); Ocean View (No. 2397).

Koellia mutica (Michx.) Britton. Dry, sandy soil, Newbern, N. C. (Nos. 1960, 2225).

Lycopus europaeus L. Adventive about wharves, Suffolk, July 18 (No. 1740).

Lycopus rubellus Moench. Frequent in wet, shaded ground, Virginia Beach, October 5 (No. 2123); margin Lake Drummond, Dismal Swamp, November 5 (No. 2358).

Lycopus virginicus L. Along a ditch at roadside, Virginia Beach, October 6 (No. 2148); in wet ground among Rhexia and *Andropogon virginicus*, eastern margin of the Dismal Swamp, November 3 (No. 2337).

Mentha rotundifolia (L.) Huds. Abundantly naturalized along a roadside near Norfolk, July 16 (No. 1692).

Mentha spicata L. Introduced on the edge of Lake Drummond, Dismal Swamp, July 14.

SOLANACEAE.

Physalis[1] **angulata** L. Cornfields, Wallaceton, July 22 (No. 1803).

Physalis virginiana Mill. In woodlands, Virginia Beach, May 29 (No. 1422), anthers violet.

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[1] Physalis determined by Dr. P. A. Rydberg.

Physalis viscosa L. In thickets of *Myrica carolinensis*, Cape Henry, scarce, May 28 (No. 1392).

Solanum carolinense L. Common in waste and cultivated land (No. 1357).

Solanum nigrum L. In a pine grove among the dunes, Cape Henry, July 26 (No. 1818).

Datura stramonium L. Along the Dismal Swamp Canal, Wallaceton, introduced.

Datura tatula L. A common, naturalized weed in waste ground.

SCROPHULARIACEAE.

Verbascum blattaria L. Naturalized in sandy fields near Norfolk, May 20 (No. 1281).

Verbascum thapsus L. Introduced at roadside near Centerville, Princess Anne County.

Linaria canadensis (L.) Dumort. Very common and abundant in sandy soil. May (Nos. 25 C. & K., 1019).

Pentstemon hirsutus (L.) Willd. In upland pine woods near Virginia Beach (No. 2098)—a glabrescent form.

Pentstemon pentstemon (L.) Britton. In a low field, with *Eupatorium rotundifolium*, Newbern, N. C. (No. 1947).

Mimulus ringens L. In marshy ground at roadside, Edenton, N. C., July 30 (No. 1909).

Monniera acuminata (Walt.) Kuntze. In moist sandy soil in the open, Edenton, N. C., July 29 (No. 1883).

Monniera monniera (L.) Britton. In brackish marshes near Virginia Beach, August 4 (No. 2016).

Gratiola pilosa Michx. Sandy soil, fields and roadsides, Northwest, July 9 (No. 1561); Edenton, N. C., July 29 (No. 1872).

Gratiola sphaerocarpa Ell. In marshy ground, usually in partial shade, Kempsville, October 7 (No. 2162); Wallaceton, November 3 (No. 2346).

Gratiola virginiana L. Moist low ground in woods near Berkley, May 21 (No. 1315).

Ilysanthes attenuata (Muhl.) Small. Edge of a cypress swamp, Edenton, N. C., July 30 (No. 1914); marshy ground beside a woodland road, Kempsville, October 7 (No. 2160).

Ilysanthes gratioloides (L.) Benth. In moist sandy soil in the open, Northwest, July 9 (No. 1544); Edenton, N. C., July 29 (Nos. 1873, 1880).

Veronica arvensis L. Grassy places near Virginia Beach, naturalized, April 29 (No. 12 C. & K.).

Buchnera elongata Sw. Dry, sandy, open ground, Newbern, N. C., July 31 (No. 1937).

Dasystoma flava (L.) Wood. Fertile soil in woods near Cape Henry (No. 1839).

Gerardia purpurea L. Common in low ground at roadsides, Virginia Beach, October 3 (No. 2074).

Gerardia sp. At a roadside through low pine woods, Newbern, N. C., October 10 (No. 2200) nearest *G. purpurea*. The same form occurs at Starkville, Miss.

Gerardia sp. Dry, sandy roadside, Newbern, N. C., October 10 (No. 2203)—apparently intermediate between *G. tenuifolia* Vahl. and *G. divaricata* Chapm.

BIGNONIACEAE.

Bignonia crucigera L. Common near the margin of Lake Drummond, Dismal Swamp, climbing high, May 1 (No. 88 C. & K.); swampy woods near Edenton, N. C. Local name, "smoke vine."

Tecoma radicans (L.) DC. Common in dry soil, especially in the pine woods inside the sand dunes, July (Nos. 1037, 1483). Local name, "devil's shoe string."

Catalpa catalpa (L.) Karst. Edges of swampy woods along streams, frequent but not abundant (No. 1329).

OROBANCHACEAE.

Orobanche minor L. A common, naturalized weed about Norfolk and Portsmouth, growing usually on *Trifolium pratense*, also on *Vicia sativa*, *Daucus carota*, *Ranunculus bulbosus*, etc., May (Nos. 1276, 1300).

Conopholis americana (L. f.) Wallr. Low woods near Virginia Beach, April 29 (No. 29 C. & K.).

PINGUICULACEAE.

Utricularia clandestina Nutt. In the Jericho Ditch, Dismal Swamp; scarce; July 15 (No. 1682).

Utricularia fibrosa Walt. In a pond, Northwest, July 9 (No. 1552).

Utricularia inflata Walt. Frequent and sometimes abundant in ponds; near Suffolk, May 19 (No. 1258); near Virginia Beach, May 29.

Utricularia purpurea Walt. Abundant in Jericho Ditch, Dismal Swamp, July 15 (No. 1608).

ACANTHACEAE.

Ruellia ciliosa Pursh. Dry sandy soil in open woods, Northwest, July 9 (No. 1565); bluff on Cohoon Creek near Suffolk, July 18 (No. 1718).

Dianthera americana L. Abundant along streams on the northern margin of the Dismal Swamp.

PHRYMACEAE.

Phryma leptostachya L. Rich low woods, Northwest, July 9 (No 1501).

PLANTAGINACEAE.

Plantago lanceolata L. Grassy lawns and roadsides, naturalized, May (No. 1326).

Plantago rugelii Dec. Grassy roadsides and fields, July (No. 1750).

Plantago virginica L. Common in sandy fields, May (No. 1146).

RUBIACEAE.

Houstonia caerulea L. Frequent in fields and on roadsides, May (No. 1200).

Oldenlandia uniflora L. Moist sandy soil on the beach, Virginia Beach, October 2 (No. 2065).

Cephalanthus occidentalis L. Frequent about ponds and along streams (No. 1453).

Mitchella repens L. Frequent in rich low woods, near Ocean View, May 30 (No. 1441).

Diodia teres Walt. Common among the open sand dunes, Ocean View to Virginia Beach (Nos. 1809, 2093).

Diodia virginiana L. Moist sandy soil among the dunes, Ocean View to Virginia Beach (Nos. 23 C. & K., 1545, 1757).

Galium[1] **aparine** L. Abundantly naturalized along railway tracks near Berkley, May 21 (No. 1311).

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[1] Species of Galium of the *tinctorium* group determined by Dr. K. A. Wiegand.

Galium circaezans Michx. Summit of a wooded bluff on Cohoon Creek, near Suffolk.

Galium claytoni Michx. Moist, shaded ground, border of a marsh, Ocean View, July 20 (No. 1766); marshes of the Northwest River, July 9 (No. 1547); open, marshy ground, margin of Lake Drummond, Dismal Swamp, July 13 (No. 1613).

Galium hispidulum Michx. Common in the dry pine woods on and behind the innermost dunes, Ocean View to Virginia Beach (Nos. 41 C. & K., 1768, 2089.)

Galium pilosum Ait. In dry soil among undergrowth, Ocean View, July 8 (No. 1481).

Galium tinctorium filifolium Wiegand. In moist, sandy, open ground near Kempsville, May 9 (No. 1054).

VIBURNACEAE.

Sambucus canadensis L. Common along ditches at roadsides and in fields (No. 1299).

Viburnum dentatum L. Frequent in swampy woods along streams (Nos. 1105, 1263, 1702).

Viburnum nudum L. Common in wooded swamps (Nos. 70 C. & K., 1174, 1292, 1438, 1664, 1796). The distinction between forms of this species and *V. cassinoides* L. is not always clear. For example, Nos. 70 and 1664 have crenulate leaf margins, while No. 1796 has the peduncle shorter than the cyme.

Viburnum prunifolium L. In deciduous woods on the bank of a pond near Suffolk (No. 1250); at water's edge along Cohoon Creek above Suffolk (No. 1701).

Lonicera japonica Thunb. Abundantly naturalized at roadsides, May (No. 1260).

Lonicera sempervirens L. Common in most formations, but especially on the inner sand dunes, scarce in the wooded swamps, April–May (Nos. 19 and 82 C. & K., 1397, 1715).

VALERIANACEAE.

Valerianella chenopodifolia (Pursh) DC. Roadside near Suffolk, May 1 (No. 74 C. & K.).

ianella radiata leiocarpa A. Gray. Sandy roadside, Northwest, May 11 (No. 1076).

CUCURBITACEAE.

Melothria pendula L. Edge of swampy woods, eastern margin of the Dismal swamp, Wallaceton, July 21 (No. 1788).

CAMPANULACEAE.

Legouzia perfoliata (L.) Britton. Along railways near Suffolk, May 19 (No. 1264).

Lobelia cardinalis L. On hummocks, swampy banks of Cohoon Creek near Suffolk, July 18 (No. 1709).

Lobelia glandulosa Walt. Open, fresh-water marshes of the Northwest River (No. 2378).

Lobelia inflata L. Sandy fields, Northwest, July 9 (No. 1497).

Lobelia nuttallii Roem. & Schult. Sandy upland soil, in the open, Suffolk, July 11 (No. 1576).

Lobelia puberula Michx. Low pine woods near Virginia Beach, October 3 (No. 2075), flowers almost rose-colored; sandy roadside along an empty ditch, Newbern, N. C., October 10 (No. 2229).

CICHORIACEAE.

Adopogon virginicum (L.) Kuntze. Sandy roadside, Suffolk, April 29 (No. 63 C. & K.).

Sonchus asper Vill. Roadside near Norfolk, introduced, May 7 (No. 1025).

Lactuca sagittifolia Ell. Low woods, Northwest, July 9 (No. 1496), lower leaves sinuate-pinnatifid.

Sitilias caroliniana (Walt.) Raf. Frequent at waysides, along railways, etc., May–July (Nos. 1356, 1519).

Hieracium gronovii L. Sandy soil, in or near open pine woods, frequent, July (Nos. 1763, 1836, 1980).

Hieracium venosum L. Dry, sandy soil, Northwest, May 11 (No. 1101).

Nabalus albus (L.) Hook. Common in low woods, Princess Anne County, October 7 (Nos. 2143, 2173).

AMBROSIACEAE.

Iva frutescens L. Common in salt marshes, October (No. 2121).

Iva imbricata Walt. Frequent on the outermost dunes, near Ocean View to Virginia Beach, October (Nos. 1752, 2061).

Ambrosia artemisiaefolia L. Abundant in old fields.

Xanthium sp. Nearest *X. italicum* Murr. On the outermost dunes at Cape Henry, October 5 (No. 2124).

Xanthium sp. Cotton fields near Newbern, N. C., common, October 10 (No. 2202).

Xanthium strumarium L. Abundant in cornfields at Wallaceton, November 3 (No. 2331).

CARDUACEAE.

Vernonia noveboracensis (L.) Willd. In low ground, frequent in fresh-water river marshes. July–October (Nos. 1706, 2181, 2389).

Vernonia noveboracensis tomentosa (Walt.) Britton. (?) Low shaded ground at roadside near Virginia Beach, October 10 (No. 2110).

Elephantopus nudatus A. Gray. Common in open pine woods, July (Nos. 1868, 2019, 2170). No. 1868 is unusually villous, and resembles *E. tomentosus* L.

Eupatorium[1] **album** L. Summit of a wooded bluff near Suffolk, July 18 (No. 1732).

Eupatorium aromaticum L. Dry pine woods near Virginia Beach, October 3 (No. 2101).

Eupatorium capillifolium (Lam.) Small. Abundant in fields and roadsides, October (Nos. 1269, 1487, 2147, 2223, 2338). Sometimes known as "jimson weed," a popular name usually given to species of Datura.

Eupatorium coelestinum L. Low ground, especially at edges of woods, common near Virginia Beach, October (No 2095).

Eupatorium linearifolium Walt. Common in dry fields and open pine woods, October (Nos. 2055, 2111).

Eupatorium maculatum L. In low ground at the edge of woods, Kempsville, October 7 (No. 2180).

Eupatorium perfoliatum L. Marshes; a peculiar small form in rather dry, sandy soil, Newbern, N. C., October 10 (No. 2238).

Eupatorium pinnatifidum Ell. In sandy fields near Newbern, N. C., October 10 (No. 2240).

Eupatorium pubescens Muhl. In dry, upland pine woods, Virginia Beach, October 3 (No. 2097).

Eupatorium purpureum L. Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1699).

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[1] Eupatorium determined with the assistance of Dr. E. L. Greene.

Eupatorium rotundifolium L. Common in rather moist, sandy fields, October (No. 1985).

Eupatorium semiserratum DC. Low pine woods, Virginia Beach, October 2 (No. 2070); Ocean View (No. 2396).

Eupatorium serotinum Michx. Low ground in pine woods, Virginia Beach, October 2 (No. 2084).

Eupatorium verbenaefolium Michx.? Border of woods, Princess Anne County, October (Nos. 2145, 2178).

Eupatorium verbenaefolium Michx. var.? In a sandy field, Newbern, N. C., October 10 (No. 2190).

Eupatorium sp. Undescribed, related to *E. hyssopifolium* L. With *E. pinnatifidum* at Newbern, N. C. (No. ——).

Willugbaeya scandens (L.) Kuntze. Frequent in marshy places (Nos. 1622, 1942, 2085).

Lacinaria graminifolia pilosa (Ait.) Britton. Dry sandy soil, pine woods and roadsides, Newbern, N. C., October 10 (Nos. 2207, 2231).

Trilisa paniculata (Walt.) Cass. In low pine woods, Newbern, N. C., October 10 (No. 2199).

Carphephorus tomentosus (Michx.) Torr. & Gr. With the preceding (No. 219).

Chrysopsis graminifolia (Michx.) Nutt. Common in dry soil in open pine woods. (No. 2393.)

Chrysopsis mariana (L.) Nutt. Often with the preceding (No. 2109).

Solidago[1] **bicolor** L. Low woods and shaded banks near Virginia Beach, October 1 (No. 2079).

Solidago canadensis L. Common in roadsides and old fields, October (Nos. 2080, 2227).

Solidago erecta Pursh. At roadsides through woodland, Northwest, November 8 (No. 2386).

Solidago fistulosa Mill. In low places in pine woods near the strand, Virginia Beach, October 1 to 6 (Nos. 2058, 2191); Newbern, N. C., October 10 (No. 2245).

Solidago neglecta Torr. & Gr. (?) Low woods, Princess Anne County, October 5 (Nos. 2164, 2177); roadsides, Newbern, N. C., October 10 (No. 2222).

Solidago nemoralis Ait. Dry soil at the border of woods, Princess Anne County, October 2 to 5 (Nos. 2099, 2156).

Solidago odora Ait. Common in pine woods (No. 1689).

Solidago petiolaris Ait. Shaded bank at roadside, in sandy soil, near Newbern, N. C., October 10 (No. 2220).

Solidago pulverulenta Nutt. Low woods near Kempsville, Princess Anne County, October 7 (No. 2157), a much-branched form; low pine woods near Newbern, N. C., abundant, October 10 (No. 2193), a slender, virgate form.

Solidago rugosa Mill. In moist ground at edge of pine woods, Virginia Beach, October 2 (No. 2078). Plant merely puberulent, with rather thin leaves and long slender branches, indicating a transition to *S. ulmifolia* Muhl.

Solidago sempervirens L. Common at the edges of salt marshes and in moist sand among the dunes, October (Nos. 21 C. & K., 2057, 2151, 2219).

Solidago sp. In a swale at roadside, Edenton, N. C., July 30 (No. 1913). Apparently nearest *S. canadensis glabrata* Porter, but the leaves strongly scabrous above; the smooth glaucous stem and the inflorescence resemble those of *S. serotina* Ait., and suggest a hybrid of that species with *S. canadensis*.

Solidago sp. nov.? In open marshy ground at roadsides, Edenton, N. C., July 30 (Nos. 1897, 1900). Leaves distinctly triple-nerved; species apparently intermediate between *S. juncea* Ait. and *S. missouriensis* Nutt. The same form was collected in west central North Carolina by Small & Heller (No. 314).

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[1] Solidago determined with the assistance of Dr. E. L. Greene.

Euthamia caroliniana (L.) Greene. Abundant among the inner dunes and in low pine woods near the strand, October (No. 2060).

Boltonia asteroides (L.) L'Hér. In open marshes of the Northwest River (No. 2392).

Sericocarpus asteroides (L.) B. S. P. Frequent in dry soil; roadsides and open woods, July (No. 1585).

Sericocarpus bifoliatus (Walt.) Porter. Dry sandy roadside, Newbern, N. C., October 10 (No. 2232).

Aster[1] **dumosus** L. In low ground at the edge of woods, Kempsville, October 7 (No. 2174).

Aster dumosus gracilentus Torr. & Gr. In a grassy meadow, Newbern, N. C., October 10 (No. 2237).

Aster elodes Torr. & Gr. In slightly moist ground among the sand dunes, among bushes of *Baccharis halimifolia* and *Myrica carolinensis*, Cape Henry, October 5 (No. 2128).

Aster elodes Torr. & Gr., var. Open marshes of the Northwest River (No. 2376).

Aster ericoides L. Common in sandy soil: fields and roadsides, October (No. 2059).

Aster gracilis Nutt. Dry, sandy roadside, Edenton, N. C., July 29 (No. 1866).

Aster laterifiorus (L.) Britton. Common in low woodlands, October (No. 2175).

Aster novi-belgii atlanticus Burgess. At the edge of swampy woods, Northwest, November 8 (No. 2367).

Aster patens Ait. Dry sandy soil at roadside, Newbern, N. C., October 10 (No. 2208).

Aster puniceus L. In a swale at roadside, Newbern, N. C.. October 10 (No. 2211); rays rose-colored.

Aster subulatus Michx. Common in salt marshes, October (Nos. 2083, 2119).

Aster tenuifolius L. With the preceding, somewhat less abundant, October (No. 2118).

Aster vimineus Lam. Rich, low woods on the eastern margin of Lake Drummond, November 5 (No. 2359).

Aster vimineus columbianus Britton. In low ground along the Dismal Swamp Canal, November 5 (No. 2355); edge of swampy woods, Northwest, November 8 (No. 2366).

Aster sp. In open low pine woods near Virginia Beach, October 6 (No. 2155). Near *A. hirsuticaulis* Lindl.

Heleastrum paludosum (Ait.) DC. Low, moist ground, in and near pine woods, Newbern, N. C., October 10 (No. 2201).

Erigeron annuus (L.) Pers. At roadsides and in fields, July (No. 1751).

Erigeron pulchellus Michx. In fertile soil in mixed woods near Suffolk, May 19 (No. 1248).

Erigeron ramosus (Walt.) B. S. P. In dry sandy soil, pine voods, frequent, May (Nos. 1234, 1425).

Erigeron ramosus beyrichii (F. & M.) Smith & Pound. In dry sandy soil; fields and open woods, Newbern, N. C., August 1 (Nos. 1936, 1988).

Erigeron vernus (L.) Torr. & Gr. Edge of swampy woods; Northwest, May 11 (No. 1097); Munden Point, Princess Anne County, May 16 (No. 1182).

Leptilon canadense (L.) Britton. Abundant in fields and roadsides (No. 1987); a glabrescent form with thickish leaves in moist sand among the dunes (Nos. 1756 (depauperate), 1807, 2054).

Ionactis linariifolius (L.) Greene. Frequent in dry, open, upland pine woods (No. 1847).

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[1] Aster determined by Dr. E. S. Burgess.

Baccharis halimifolia L. Abundant on and near the strand, among the dunes, at the edge of salt marshes, in low woods, etc.; less common farther inland, along ditches and in moist woods, October (Nos. 1058, 1163, 2051, 2131).

Pluchea camphorata (L.) DC. In a marshy place among the inner dunes, Virginia Beach, October 2 (No. 2082).

Pluchea foetida (L.) B. S. P. In a bog, Newbern, N. C., August 1 (No. 1972); in boggy places in pine woods behind the dunes, Ocean View, November 11 (No. 2394).

Antennaria[1] **arnoglossa** Greene. In woods near Suffolk, April (Nos. 58 C & K., 1244).

Antennaria decipiens Greene. In low pine woods, Portsmouth, April 27 (No. 27 (No. 1 C. & K.)).

Antennaria fallax Greene. With the preceding (No. 1a C. & K.).

Gnaphalium helleri Britton. Common among the sand dunes and in the pine woods behind, Cape Henry to Virginia Beach, October (No. 2052).

Gnaphalium purpureum L. In sandy fields, and frequent among the dunes at Virginia Beach, May (Nos. 1031, 1415, 1485).

Polymnia uvedalia L. In fertile soil at the edge of woods, near Suffolk; near Virginia Beach.

Silphium trifoliatum L. Dry soil at roadside near Virginia Beach (No. 2106).

Parthenium integrifolium L. Low ground near Suffolk, May 19 (No. 1254).

Eclipta alba (L.) Hassk. Cornfields near Newbern, N. C., July 31 (No. 1950).

Rudbeckia laciniata L. In a swale at roadside, Newbern, N. C., October 10 (No. 2209).

Borrichia frutescens L. Edge of a salt marsh, Tanners Creek, near Norfolk, July 16 (No. 1693).

Helianthus angustifolius L. In sandy soil, openings in pine woods, Newbern, N. C., October 10.

Helianthus atrorubens L. Dry sandy soil in pine woods, near Suffolk; near Lynnhaven Bay.

Verbesina occidentalis (L.) Walt. Roadsides near Virginia Beach, October 3.

Verbesina virginica L. With the preceding (No. 2105).

Coreopsis angustifolia Ait. Low pine woods, Newbern, N. C., October 10 (No. 2192).

Coreopsis gladiata Walt. (?) Marshy shores of the Trent River, with *Chamaecrista fascicularis* and *Centella asiatica*, Newbern, N. C., October 10 (No. 2213). Stems more branching and leafy and heads smaller than is ordinarily the case in *C. gladiata*.

Bidens bipinnata L. Naturalized at roadsides and in waste ground.

Bidens cernua L. Marshes of the Northwest River (No. 2391).

Bidens frondosa L. Shaded ground at roadsides, Virginia Beach, October 6 (No. 2154).

Bidens trichosperma (Michx.) Britton. Marshes of the Pasquotank River, August 2 (No. 1991).

Bidens trichosperma tenuiloba (A. Gray) Britton. Marshes of the Northwest River, November 8 (No. 2375).

Achillea millefolium L. Abundantly naturalized in fields and roadsides, May–July (No. 1304).

Achillea millefolium L. var. In open pine woods near the strand, growing with *Apocynum pubescens*, etc., Ocean View, July 8 (No. 1482). Stem more rigid, plant somewhat tomentose, inflorescence small, very compact, leaves more appressed to the stem.

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[1] Antennaria determined by Dr. E. L. Greene.

Chrysanthemum leucanthemum L. Abundantly naturalized in fields and waste ground, May (No. 1289).

Arnica acaulis (Walt.) B. S. P. Frequent in rather low woods near Suffolk, May (Nos. 65 C. & K., 1231)

Erechtites hieracifolia (L.) Raf. In open woods and clearings, common, October (Nos. 1614, 2167).

Senecio smallii Britton. A single large clump along a railway near Suffolk, appearing as if introduced (from western Virginia?), May 19 (No. 1271).

Senecio tomentosus Michx. Abundant in fields and roadsides, especially in rather moist ground, April-May (Nos. 26 and 46 C. & K.).

Arctium lappa L. In waste ground at Deep Creek, Norfolk County; introduced.

Carduus spinosissimus Walt. In moist sandy soil, in the open, especially common near the strand, May (Nos. 1211, 1253).

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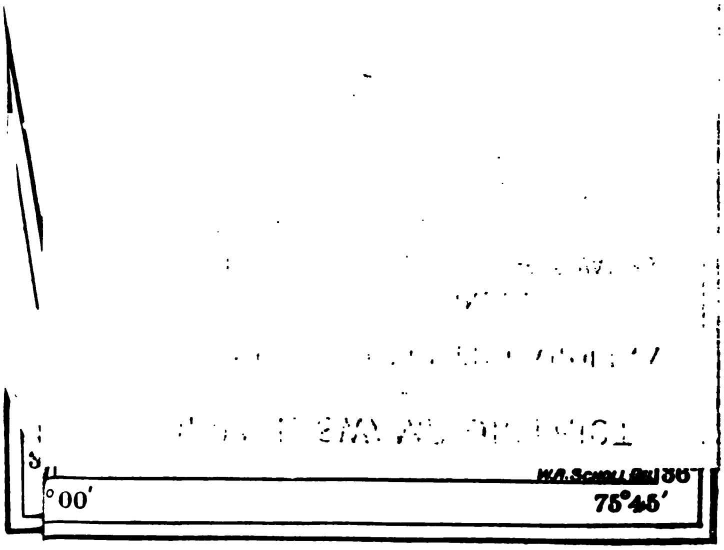
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INDEX.

[Synonyms printed in *italics*.]

A.

Page.
Abies concolor 31, 43, 48, 88
  lasiocarpa 43, 49, 56
Abutilastrum 177
Abutilon andreuxii 171
  bakerianum 133
  cinctum 178
  discolor 133
  crispum 170
  goldmani 170
  holosericeum 178
  incanum 170
  jaquini 170
  macranthum 133, 134
  nelsoni 134
  newberryi 180
  notolophium 133
  reticulatum 171
  reventum 171
  sp 171
  sylvaticum 170
  trilobatum 178
  venosum 171
  wissaduloides 179
Acacia berlandieri 194
  spadicigera 257
  subangulata 194
Acalypha gracilens 316, 531
  phleoides 229
Acanthaceae 462, 541
Acanthocarpae 141
Acer campestre 494
  distylum 494
  drummondii 532
  glabrum 55
  rubrum 334, 335, 379, 398, 404, 418, 421, 423, 426, 429, 431, 433, 436, 476, 479, 480, 485, 493, 494, 524, 532
  saccharinum 482
Aceraceae 462, 532
Achillea millefolium 105, 408, 546
Achras sapota 222
Acorus 442, 458
  calamus 30, 315, 437, 442, 460, 520
Acrocomia sclerocarpa 214
Acrostichum conforme 146
  jamesoni 146
  obtusifolium 146
  pilosum 146
  piloselloides 146

Page.
Acrostichum spathulatum 146
Actinospermum uniflorum 457
Acupa 257
Adaptations to environment of plants 275-280, 382, 398, 429, 440, 442, 446
Adiantum aethiopicum 147
  capillus-veneris 147, 228
  patens 147
  thalictroides 147
Adopogon 458
Aerating adaptations of swamp plants 438
Aërenchyma 443
Aeschynomene 191
  acapulcensis 191
  amorphoides 191
  compacta 191
  fascicularis 191, 192
  fruticosa 192
  hispida 316
  palmeri 192
  paniculata 192
  petraea 192, 193
  simulans 192
  virginica 316, 454
  viscidula 191
Aesculus pavia 451
Agave 145, 151, 152, 153, 154, 156, 210, 232, 234, 239, 242, 243, 245, 246, 247, 249, 250
  alibertii 156
  americana 156, 224, 245, 247, 249
  atrovirens 245
  aurea 247
  brachystachys 233, 234, 237
  cochlearis 245, 247, 249
  decipiens 247
  falcata 245, 247
  fiber 237, 240, 242, 250
    instruments 244
  filifera 237, 246, 249
  geminiflora 245, 247, 249
  guttata 234, 237
  heteracantha 233, 237, 239, 242, 247
  ixtle 243
  leaves 248, 252
  lechuguilla 233, 237, 242, 247
  lophantha 242, 247
  mexicana 237, 247
  morrisii 247
  parryi 237
  plants, use in making Tampico hemp 210, 242

Page.
Agave *polianthoides* 152
  poselgerii 242
  potatorum 247
  potosina 157
  protuberans 156
  rigida 239
    elongata 247
    sisalana 247
  saponaria 152, 233
  spp 223, 233, 242, 246, 247, 255
  striata 241, 245
  strings 257
  univittata 242, 247
  variegata 233, 237
  vestita 247
  virginica 155, 156, 246
  vivipara 246, 247, 249, 250, 252
Agaveae 151, 153
  proposed rearrangement 151-157
Agaves, study and collection 210
Agricultural crops, Cœur d'Alenes 29-31
Agriculture in Cœur d'Alenes 3
Agrimonia 458
  parviflora 528
  striata 450, 528
Agropyron divergens 36
  tenerum 36
Agrostemma githago 414, 525
Agrostis alba 36, 515
    vulgaris 469, 515
  altissima 451, 515
  elliottiana 451
  hiemalis 515
  intermedia 515
  perennans 91
  scabra 35
  tenuis 35
Agua de cebada 225
Aguacate 215, 226
  salad 226
Aguardiente 224
Ahuacate 215
  grande 215
Ailanthus glandulosa 531
Air currents in Cœur d'Alenes 15-22
Aira caryophyllea 516
  praecox 387, 516
Aizoaceae 316, 462, 525
Ajonjoli 226, 235, 237
Albizzia julibrissin 413, 529
Alder 55, 59, 60, 94, 436
  black 419
Alectoria fremontii 38, 87
  ochroleuca 38
Aletris aurea 453
Aleuritopteris lutea 148
Algae 374
  fresh-water 314
Alibertia 156
  intermedia 158
Alismaceae 90, 462, 513
Alleghanian zone 450
Alligator pear 215
Allium vineale 414, 521
Allosorus angustifolius 149
  cordatus 149

Page.
Almendra 221
Almonds, Mexican 221
Alnus 458
  rhombifolia 55
  rugosa 419, 436, 523
  tenuifolia 55, 94
  viridis 55
Aloe sp 228
Alopecurus geniculatus 35, 460, 515
  occidentalis 35
Alote 218
Alsike clover 469
Alsinaceae 316, 525
Alsine media 413, 472, 528
Altea 230
Altingia 490
Altitudes of Cœur d'Alenes 7
Amarantaceae 96
Amaranth 96
Amaranthus retroflexus 414
  spinosus 414
Amarantus blitoides 96
Amaryllidaceae 233, 242, 462, 522
Ambrosia artemisiaefolia 275, 318, 409, 413, 414, 460, 472, 543
Ambrosiaceae 462, 543
Amelanchier 458
  alnifolia 38, 55, 97
  botryapium 400, 404, 426, 471, 528
American elm 399
  olive 483
Ammania koehnei 274, 303, 310, 311, 312, 313, 317, 455
Ammodenia 458
  peploides 368, 382, 449, 460, 528
Ammophila 368, 370, 371, 382, 383, 384, 388, 394, 458
  arenaria 270, 333, 368, 369, 370, 379, 382, 383, 388, 389, 390, 392, 393, 449, 515
Amole 152, 231, 233, 234, 236, 237
  soap 232
Amolilla 234, 237
Ampelopsis 416
  arborea 416, 421, 454, 533
Amphicarpaea 458
  monoica 416
Amphicarpon amphicarpon 451
Amsonia angustifolia 456
Amygdalaceae 462, 528
Amyris thyrsiflorus 112
Anacardiaceae 217, 316, 462, 532
Anatomy, notes, Dismal Swamp plants 484-509
  Ocracoke Island plants 280-312
Andromeda 426
Andropogon 405
  argyraeus 45, 513
  elliottii 513
  glomeratus 271, 315, 378, 438, 451, 513
  gracilior 513
  macrourus 315
  macrourus 274
  scoparius 405, 513
  sorghum halepensis 513
  spp 402, 468
  tetrastachyus 451, 513
  virginicus 397, 408, 409, 468, 472, 518, 539, 543
Andropogoneae 461

Page.
Anemophilous pollination ... 398
Angelica ... 202
  roseana ... 201
Angiospermae ... 513
Anguria dubia ... 121
Anoda ... 173
  abutiloides ... 172
  acerifolia ... 172
  caudatifolia ... 172
  crenatiflora ... 172
    glabrata ... 172
  cristata ... 172
  hastata ... 172, 230
  incarnata ... 173
  parvifolia ... 172
  pentaschista ... 172
  punicea ... 173
Anona ... 215
  cherimolia ... 215
  glabra ... 215
  longiflora ... 215
  sp ... 228
  triloba ... 482
Anonaceae ... 215, 228, 462, 526
Antennaria arnoglossa ... 546
  decipiens ... 546
  fallax ... 546
Anthaenantia villosa ... 451
Anthemideae ... 461
Anthoxanthum odoratum ... 515
Apiaceae ... 101, 317, 462, 535
Apios ... 458
  apios ... 416, 421, 435, 440, 530
  tuberosa ... 416, 435, 440
Apocynaceae ... 103, 462, 538
Apocynum cannabinum ... 103, 538
  pubescens ... 538, 546
Apodanthera pringlei ... 121
  roseana ... 121
Appalachian area ... 450
Apples ... 30, 31, 214, 412, 464, 470
  possum-pocket ... 526
  red Astrakhan ... 470
Apricot ... 214
Aquatic plants, classification ... 445, 446
  vegetation ... 443–447
Araceae ... 315, 462, 520
Aralia spinosa ... 379, 380, 393, 400, 404, 405, 455, 476, 477, 478, 479, 535
Araliaceae ... 462, 535
Arbor vitae ... 43, 51
Arbutus sp ... 256
Arctic alpine zone ... 447
Arctium lappa ... 547
Arctostaphylos nevadensis ... 102
  patula ... 102
  uva-ursi ... 103
Arenaria caroliniana ... 453
Areocarpus fissuratus ... 258
Argithamnia sp ... 227
Arisaema triphyllum ... 520
Aristida ciliata ... 285
  dichotoma ... 515
  lanata ... 451
  purpurascens ... 401, 515
  spp ... 392

Page.
Aristida stricta ... 406, 451, 515
  virgata ... 451
Aristolochia nashii ... 453, 524
  serpentaria ... 405, 524
Aristolochiaceae ... 462, 488, 506, 524
Arnica acaulis ... 457, 547
Aroids ... 436
Aronia ... 458
  arbutifolia ... 400, 426, 528
  nigra ... 528
Arrayan ... 221, 225
Arrow, indian ... 251
  shafts ... 92, 97, 99
  tips ... 97
Arrowhead ... 90, 100
Arrow wood ... 97
Artemisia tridentata ... 88, 98, 105
Arundinaria ... 404, 416, 429
  macrosperma ... 314, 339, 417, 422, 427, 435, 449, 452, 468, 472, 479, 517
  tecta ... 335, 401, 404, 438, 452, 468, 476, 479, 517
Asarum ... 458
  arifolium ... 453, 488
  virginicum ... 402, 405, 485, 487, 488, 506, 521, 524
Asclepiad ... 273
Asclepiadaceae ... 317, 462, 538
Asclepias amplexicaulis ... 456
  lanceolata ... 437, 456, 538
  paupercula ... 437
  pulchra ... 538
  rubra ... 456
  tomentosa ... 456
  variegata ... 538
Ascyrum ... 458
  crux-andreae angustifolium ... 533
  hypericoides ... 317, 533
    angustifolium ... 533
  stans ... 405, 415, 454, 485, 495, 533
Ash, black ... 482
  blue ... 481, 482
  mountain ... 55, 60
  water ... 419
  white ... 53, 419, 482
Asimina ... 458
  foetida ... 134
  triloba ... 471, 526
Asparagus ... 347, 411, 464, 466
  officinalis ... 521
Aspen ... 55, 94
Asperula ... 506
Aspidium ... 146, 450
  amplum ... 147
  conterminum ... 147
  macrophyllum ... 147
  martinicense ... 147
  molle ... 147
  parasiticum ... 147
  patulum ...
Asplenium ebeneum ... 148
  ebenoides ...
  filix-foemina ...
  minor ...
  monanthum ...
  parvulum ...
  platyneuron ...
  resiliens ...

Page.
Asplenium trichomanes 148
  trilobum 148
Aster 367, 409
  linariifolius 402
  concolor 457
  coridifolius 457
  diffusus 423
  dumosus 307, 545
    gracilentus 545
  elodes 545
  ericoides 307, 409, 472, 545
  flexuosus 280
  gracilis 405, 457, 545
  hirsuticaulis 545
  latahensis 201
  lateriflorus 545
  novi-belgii atlanticus 545
  paludosus 406, 457
  patens 545
  puniceus 307, 545
  purpuratus 457
  salicifolius 318
  sp 366, 545
  squarrosus 457
  subulatus 273, 280, 306, 307, 310, 311, 312, 313, 318, 363, 365, 366, 545
  tenuifolius 283, 306, 307, 310, 311, 312, 313, 318, 363, 366, 457, 485, 545
  vimineus 545
    columbianus 545
Astragalus glaber 454
Atamosco atamasco 402, 449, 453, 522
Atmospheric humidity, Ocracoke Island 264
Atriplex hastata 273, 313, 316, 364, 460, 525
Attalea cohune 232, 237
Attole 218
Aulacomnium palustre 511
    polycephalum 511
  sp 511
Austral region 447
Austroriparian area 447, 448, 449, 459
  plants 449–457
Avocado pear 215
Ayenia fruticosa 195
Azafran 227
A al. 259
Azalea 426, 458, 459
  canescens 400, 404, 536
  viscosa 426, 510, 536

B.

Baccharis 366, 367, 372, 458
  angustifolia 457
  dioica 307
  glomeruliflora 457
  halimifolia 273, 283, 307, 310, 311, 312, 313, 318, 363, 364, 372, 373, 380, 394, 400, 408, 409, 457, 508, 545, 546
Baccharis-Hibiscus association 350, 364
Bald cypress 417, 418, 433, 443
Balm of Gilead 55, 94
Balsam fir 49
Balsamorrhiza deltoidea 108
  sagittata 108
Bamboo 241, 250, 252, 256

Page.
Banana 214, 363
Banco del ide 244, 248
Baptisia 458
  tinctoria 529
  villosa 454
Barley 225, 230, 411, 468, 469
  little 472
Barnyard grass 414, 472
Barren oak 483
Bartonia 458
  verna 458
  virginica 405, 538
Baskets 89, 92, 94, 99
Bastardia hirsutiflora 178
Bastardiastrum 178
Batodendron arboreum 455, 485, 502, 537
Bay 419, 477, 483, 526
  evergreen loblolly 483
  sweet 399, 425, 479, 480, 483
  white 483
Bays, juniper 483
Beach, Dismal Swamp region 367–370
  Formation 269, 270
Beans 210, 212, 347, 465, 466
  lima 411
  Mexican 210, 212, 213
  string 411, 466
  wax 213
Bear grass 32, 60
Bearberry 102
Beckmannia erucaeformis 36, 91
Beech 400, 402, 407, 426, 479, 482, 483
  blue 419, 478
Beets 465
Beggar weed 484
Bejuco colorado 253, 255, 256
  de amole 255, 256
    huico 231
Benzoin benzoin 537
  melissaefolium 453
Berberidaceae 96, 462, 536
Berberis repens 96
Berchemia scandens 314, 401, 416, 420, 431, 432, 436, 454, 449, 485, 494, 533
  volubilis 416, 479
Bermuda grass 414, 472
Beschorneria 153
Bessera 256
  fistulosa 256
Betula occidentalis 55
  papyrifera 55
Betulaceae 94, 462, 533
Beverage plants of Mexico 223–226
Beverages, distilled 223, 224
  fermented 223, 224
  nonintoxicating 224
Bibliography 547
  of Dismal Swamp region 509
    Ocracoke Island 319
Bidens bipinnata 275, 318, 414, 460, 546
  cernua 460, 546
  coronata 457
  frondosa 546
  palmeri 145
  trichosperma 437, 546
    tenuiloba 546
Big cane 479

Page.
Bignonia 421, 458
  crucigera 401, 405, 416, 420, 449, 456, 540
Bignoniaceae 231, 258, 462, 540
Birch 55
Black alder 419
  ash 482
  cherry 373, 378, 399, 407, 429, 477
  gum 334,
      399, 404, 417, 418, 419, 420, 421, 422, 423, 424,
      426, 427, 429, 435, 479, 480, 481, 483, 527, 536
    or Dark, swamp 417-423
    swamp 422
  locust 380
  medick 412
  oak 482
  pine 43, 46, 48, 58, 59, 60, 68, 70, 87, 89
  walnut 399, 478, 479
Blackberry 38, 99, 214, 407, 408, 470, 471
  brandy 225
  common high 471
  sand 380, 470, 471
  Wilson 470
Black-jack oak 482
Blue ash 481, 482
  beech 419, 478
  flag 98
  grass 412
    Kentucky 469
  tangle 479
Blueberry 477, 479
Boar wood 480, 532
Boehmeria cylindrica 423, 524
Bohadschia humifusa 166
Boliyo 244, 248
Boltonia 458
  asteroides 545
Bombaceae 171-181
Bombax palmeri 179
Boraginaceae 462, 539
Boreal region 447
Borrichia 366, 458
  arborescens 310
  frutescens 278, 279,
      283, 309, 310, 311, 312, 313, 318,
      364, 366, 449, 457, 460, 485, 546
Botrychium obliquum 512
Bouvardia cordifolia 506
Bows, wood used 89
Bradburya 405, 458
  virginiana ... 382, 385, 402, 408, 416, 454, 460, 580
Brandegea 115, 119, 120
  bigelovii 120
  minima 121
  monosperma 120
  palmeri 120
  parviflora 120
Brassica campestris 527
Brassicaceae 98, 527
Bravoa 151, 152, 153, 154
  densiflora 152, 155
  geminiflora 154, 237
  singuliflora 152
Brazil 237
  wood 251
    dye 240, 241
Bread, corn and wheat 210
Page.
Breweria aquatica 456
  humistrata 456
  pickeringii 456
Bromelia 215, 225, 255
  pinguin 255
  sylvestris 243
Bromeliaceae 215, 315, 462, 520
Bromus breviaristatus 36
  secalinus 414, 517
Brongniartia diffusa 194
  lunata 194
  suberea 194
Broom plants of Mexico 252
  rape 413
  root 252, 253
  sedge 397, 408, 468, 472
Brooms 252, 253
Broussonetia papyrifera 275, 316, 413, 524
Brush 239, 240, 242, 249, 252, 254
  plants of Mexico 252
Brushes, fly 240, 252
  hair 252, 253
Bryaceae 511
Bryonia attenuata 121
Bryophyta 421, 461, 510
Bryum argenteum 272, 314
Buchnera elongata 456, 510
Buckbrush 98
Buckeye 482
Bulb-forming plants 402
Bulbs 435
Bull pine 43
Bulrush 437
Bumelia lycioides 455
Bunch grass 36
Bur reed 80, 90
Burned areas in Cœur d'Alenes 71-75
Burro 244
Bursera aptera 113
  bicolor 113
  cerasifolia 113
  cuneata 114
  diversifolia 113
  fragilis 113
  galeottiana 114
  glabrescens 113
  jonesii 113
  jorullensis 113
  lanuginosa 114
  laxiflora 113
  microphylla 114, 236
  morelensis 113
  nelsoni 113
  ovalifolia 114
  palmeri 113, 114
  glabrescens 113
  pringlei 113
  schaffneri 113
  submoniliformis 113, 114
  tenuifolia 113
  trijuga 113
Burseraceae 113
Buttercup 414
Butterweed, yellow-flowered 473
Buttonwood 413, 420, 478
Byrsonima crassifolia 217, 257

C.

Page.
Cabbage 226, 346, 347, 354, 357, 410, 411, 465, 466, 481
Cables 242
Cabomba caroliniana 453
Cacahuate 235
Cacahuianche 235
Cactaceae 220, 253, 254, 257, 317, 391, 462, 534
  superstitions respecting 258
Cactus 258
Caesalpinaceae 316
Caesalpinia coriaria 238
Cakile 386, 394, 458
  edentula 368, 370, 382, 385, 391, 527
Calaleasilla 236
Calamagrostis canadensis dubia 36
  purpurascens 36
  suksdorfii 36
Calliandra 193
  bijuga 135
  californica 135
  emarginata 194
  laevis 194
  oaxacana 193
  penduliflora 193
  peninsularis 135
  unijuga 193
Callicarpa americana 317, 379, 380, 400, 449, 456, 477, 479, 539
Callitrichaceae 462, 532
Callitriche heterophylla 445, 446, 532
Calochortus macrocarpus 93
Calopogon 458
Camas 37, 38, 93
  poison 93
  sticks 98
  white 93
Camassia esculenta 37
Campanulaceae 462, 542
Campulosus aromaticus 406, 451, 516
Cana dulce 234, 235, 237
Canadian zone 447
Canal, Dismal Swamp 339, 340, 356
Canavalia 374
Cane 314, 422, 427, 428, 468, 471, 472
  big 339, 479
  grass 91
  small 476, 477, 479
  sugar 224, 433
Canebrake 427
Cantaloupes 347, 411, 465, 466, 470
Caprifoliaceae 462, 508
Capriola dactylon 270, 275, 276, 315, 395, 414, 472, 516
Capsicum 210, 211
  annuum acuminatum 211
  cerasiferme 211
  frutescens 211
  grossum 211
  longum 211
Cardamine arenicola 453, 527
Carduaceae 105, 318, 462, 543
Carduus repandus 457
  spinosissimus 271, 318, 402, 408, 547
  virginianus 457
Carex 92, 457, 461

Page.
Carex alata 519
  albo-lutescens 519
  bullata 519
  canescens 450, 460, 519
    oregana 37
  comosa 519
  costellata 450, 519
  elliottii 452
  festiva 37
    stricta 37
  geyeri 37, 58
  glaucodea 519
  grandis 452
  gynandra 437, 519
  laxiflora 519
  littoralis 452
  lupulina 519
  lurida 519
  nudata 37
  pedicellata 519
  pennsylvanica 519
  pratensis 37
  rosea 519
  scoparia 519
  sterilis 519
  stipata 37, 519
  straminea 37
  stricta 437, 519
  tenuis 519
  triceps 519
  venusta 452
  verrucosa 314, 406, 439, 440, 449, 452, 520
  virescens 520
  vulpinoidea 520
  walteriana 452
Carica papaya 214
Carolinian area 447, 448
Carphephorus bellidifolius 457
  tomentosus 406, 457, 544
Carpinus 458
  caroliniana 404, 419, 523
Carrot, wild 414
Carum gairdneri 101
  oreganum 161
  petroselinum 226
Caryophyllaceae 462
Cascalote bean 238
Cascara sagrada 100
Casimiroa edulis 165, 217
Cassia hypoleuca 136
  nelsoni 136
  occidentalis 275, 316
  pringlei 194, 195
  unijuga 195
  wislizeni 195
Cassiaceae 462, 529
Cassytha filiformis 374
Castalia 444, 448
  odorata 444, 446, 528
Castanea 458
  pumila 399, 405, 407, 523
Castanopsis chrysophylla minor 94
Castor bean 235
  oil 232
Catalpa bignonioides 429
  catalpa 540

Page.
Cat-tail 30, 90, 363
  flag 90
Cayaponia attenuata 121
  dubia 121, 236
  grandiflora 123
Ceanothus 69, 494
  americanus 533
  prostratus 100
  sanguineus 58
Cebatha carolina 453
Cebollos 226
Cedar 43, 51, 55, 59, 64, 66, 74, 88, 482
  in Cœur d'Alenes 51, 52
  red 43, 55, 88, 399, 407, 477, 483
  Spanish 189–191
  white 340, 350, 417, 423, 480, 483
Cedrela 189
  angustifolia 190, 191
  fissilis 191
  imparipinnata 190
  mexicana 190, 191
  montana 189, 190
    mexicana 190
  oaxacensis 190, 191
  occidentalis 190
  odorata 190
Ceiba casearia 180, 250
  grandiflora 180, 250
  spp 250
  tomentosa 180
Celantillo de ojo de agua 228
Celastraceae 109, 462, 532
Celastrus pringlei 195
Celery 354, 357, 411, 465, 481
Celtis 537
  folliis villosis 482
  occidentalis 399, 471, 524
  pumila 524
Cenchrus incertus 451
  tribuloides macrocephalus 370, 377, 382, 387, 394, 451, 460, 515
Centella asiatica 274, 313, 317, 378, 437, 455, 459, 529, 535, 546
Central America, studies of plants 145–200
Centrosema 458
  virginiana 382, 385, 402, 416
Cephalanthus 372
  occidentalis 372, 436, 460, 541
Cerasus virginiana 482
Cerastium viscosum 413, 526
  vulgatum 526
Cercis 458
  canadensis 399, 529
Cercocarpus betulaefolius 98
  ledifolius 93, 98
Cereal crops, Dismal Swamp region 411
Cereals 38, 210
  in Dismal Swamp region 463, 467, 468
  of Mexico 210–213
Cereus 220
  geometrizans 220
  giganteus 220
  marginatus 254
  pecten-aboriginum 221, 253, 254
  pitahaya 220
  spp 220

Page.
Cereus tetazo 220
  thurberi 220, 254
  variabilis 220
Cespitose form 276
Chaetocalyx schottii 158
  wislizeni 158
Chaetochloa glauca 472, 515
  imberbis 515
    perennis 273, 315, 451, 515
  italica 412
  perennis 451
  ventenatii 515
  versicolor 315
Chamaecrista aspera 454, 529
  fascicularis 460, 468, 529, 546
  nictitans 405, 529
Chamaecyparis 423, 424, 480
  spheroidea 483
  thyoides 417, 423, 424, 425, 434, 451, 512
Chaptalia tomentosa 457
Cheilanthes angustifolia 149
  aurantiaca 148
  cuneata 149
  lendigera 149
  ochracea 148
Chenopodiaceae 95, 228, 316, 462, 525
Chenopodium 393
  album 414, 525
  ambrosioides 525
  anthelminticum 275, 316, 377, 392, 414, 525
  fremonti 95
  incisum 228
  quinoa 96
Cherries 30, 31, 55, 412, 482
Cherry, black 373, 378, 399, 407, 429, 477
  quinine 99
  wild bitter 98
Chess 414
Chestnut 482
  oaks 483
Chia 225
  grande 225
Chicasaw plum 380, 407, 471
Chickweed 413, 472
  mouse-ear 413
Chicle gum 222
Chico 215
Chicoyote 121
Chilacayote 223
Chile 211
  ancho 211
  cara 211
  colorado 226
  mirasol 211
  pequin 211
Chili sauce 211, 212
Chimaphila 458
  maculata 536
  umbellata 460, 536
Chinaberry 413
Chinook winds 13, 21, 28
Chinquapin 94, 399, 407
Chionanthus 458
  virginica 429, 482, 485, 504, 537
Chirimoya 215
Chittim wood

Page.

- Chloris petraea, 270, 271, 281, 282, 290, 291, 292, 299, 300, 313, 515, 451
- Chocolate sticks, 256
- Chokecherry, 98
- Chondrophora nauseosa, 106
  - nudata, 457
- Chrysanthemum leucanthemum, 547
- Chrysopsis, 380, 458
  - graminifolia, 382, 404, 405, 544, 457
  - mariana, 457, 544
  - pilosa, 457
  - spp, 462
- Chrysothamnus bloomeri, 106
- Cicer arietinum, 213
- Cichoriaceae, 318, 462, 543
- Cicuta, 101, 458
  - maculata, 101, 436, 442, 535
- Cinna pendula, 36
- Cinnamon bark, 226
- Circaea, 458
  - lutetiana, 460, 535
- Ciruela, 210, 217, 218, 219, 220, 225
  - amarilla, 218, 219, 220
  - campechana, 220
  - colorada, 220
  - red, 218, 219
  - roja, 218, 220
  - wild, 219
  - yellow, 218, 219
- *Cissus stans*, 416
- Cistaceae, 317, 462, 497, 533
- Cistus creticus, 497
- Citrullus vulgaris, 318
- Citrus medica, 165
- Cladium, 442
  - effusum, 274, 279, 315, 437, 442, 449, 452, 519
- Claret, 225
- Cleared land formations, 406–414
- Clematis crispa, 416, 421, 436, 449, 453, 526
- Cleome humilis, 196
  - tenuis, 196
- Clethra, 404, 422, 426, 477
  - alnifolia, 400, 404, 422, 426, 436, 476, 536
- Clethraceae, 462, 536
- Climate of Cœur d'Alenes, 2, 13–22
  - Dismal Swamp region, 324–330
  - Ocracoke Island, 262–266
- Climbing plants in Dismal Swamp, 416
- Clinopodium carolinianum, 456
- Clitoria glycinoides, 169
  - *grandiflora*, 170
  - humilis, 169
  - javitensis, 169
  - mariana, 168, 169, 170, 416, 530
  - Mexican species, notes, 168–170
  - mexicana, 168, 169
  - multiflora, 169
  - polystachya, 169
  - portobellensis, 170
  - *schiedeana*, 170
  - *sericea*, 170
  - speciosa, 170
  - subsessilis, 169
  - ternatea, 168
  - triflora, 169
- Cloth, 242
- Cloth, woven of bark, 94
- Clothesline, 255
- Clover, 412, 413, 469, 473, 480
  - alsike, 469
  - crimson, 412, 469
  - Japan, 408, 468
  - red, 412, 413, 469, 472
  - yellow, 408
- Clusiaceae, 436
- *Cnicus horridulus*, 271, 318
- Coal, how formed, 418
- Cocklebur, 413, 414, 472
- Cockle, corn, 414
- Cocoanut, 214
- Cocojul, 214
- Cocurste, 215
- Cocurstle, 215
- Cœur d'Alene Mountains, botanical survey, 1–85
- Cœur d'Alenes, agricultural capacity, 25–29
  - agricultural crops, 29–31
  - climate, 13–22
  - description, 8, 9
  - drainage system, 10–13
  - forest destruction, 61–75
  - forest fires, 62–71
  - forest preservation, 75–85
  - forest resources, 42–55
  - grazing, 31–34
  - irrigation, 40–42
  - location and area, 6
  - mineral deposits, 22–25
  - native food plants, 37, 38
  - rain and snow fall, 13, 14
  - soils, 28, 29
  - topography, 6–10
  - uses of water, 38–42
- Coffee substitute, 90
  - tree, 482
- Cogollo, 242, 243, 244, 248
- Coleosporium sonchi-arvensis, 510
- Cologania erecta, 136
  - procumbens, 136
- Comandra, 458
  - umbellata, 524
- Combretaceae, 221, 497
- Combretum palmeri, 136
- Commelina erecta, 520
  - hirtella, 453
  - nodiflora, 453
- Commelinaceae, 462, 520
- Compositae, 145, 231, 273, 279, 380, 462, 405, 408, 413, 416, 461
- Congo-red test paper, use, 330
- Coniferae, 462
- Conifers of Cœur d'Alenes, 43–55
- Conopholis, 458
  - americana, 462, 541
- Convolvulaceae, 317, 462, 538
- Convolvulus americanus, 380, 538
  - repens, 538
- Coquito, 232, 237
- Corallocarpus emetocatharticus, 121
- Coreopsis, 314
  - angustifolia, 546
  - delphinifolia, 457

Page.
Coreopsis gladiata ... 457, 529, 546
  rosea ... 457
Coriander ... 226
Coriandrum sativum ... 226
Corms ... 435
Corn ... 210, 358, 356, 357, 411, 466, 467, 468, 469, 473, 480, 481
  black ... 413
  bread ... 210
  cakes ... 210
  cockle ... 414
  horse-tooth ... 467, 481
  indian ... 210, 411, 412
  meal ... 210
  seed ... 481
  sweet ... 465
  white dent ... 467
Cornaceae ... 462, 536
Cornel ... 429
  red ... 59
Cornus ... 458
  candidissima ... 429, 536
  florida ... 398, 404, 405, 473, 478, 536
  stricta ... 449, 455, 536
Coronopus didymus ... 413, 472, 527
Corpus ... 228
Corrals ... 240
Corylus californica ... 94
Cotton ... 251, 411, 412, 464, 465, 467, 468, 470, 473, 477, 480
  gum ... 479
  in Dismal Swamp region ... 411, 463, 468
  seed oil ... 232
  spinning ... 251
  wild ... 364, 533
Cottonwood ... 55, 94, 480, 483
Couepia kunthiana ... 196
  polyandra ... 196, 216
Covillea tridentata ... 229
Cow itch ... 532
  oak ... 398, 400, 479
  parsnip ... 101
Cowpea ... 412, 469, 480
  black-eye ... 469
  hay ... 469
Crab apple ... 241
    narrow-leaved ... 482
  grass ... 411, 414, 469, 472
    sprouting ... 414, 472
  hay ... 469
Cracca ... 402
  ambigua ... 454
  hispidula ... 454
  spicata ... 405, 454, 529
Cranberry ... 104, 354, 378, 471
Crataegus ... 216, 241, 458
  apiifolia ... 454
  coccinea ... 528
  crus-galli ... 528
  douglasii ... 55
  spathulata ... 454
  tomentosa ... 55
  uniflora ... 408, 528
Creek-marsh Formation ... 272
Crescentia alata ... 258, 259
  fruit vessels ... 259

Page.
Cress, wart ... 472
Crimson clover ... 412, 469
Cross-ties, railroad ... 50, 51, 55, 63, 66
Cross-vine ... 420
Crotalaria filifolia ... 136
  purshii ... 405, 454, 529
  rotundifolia ... 454
Croton ... 231
  glandulosus ... 531
  maritimus ... 270, 271, 279, 296, 299, 300, 313, 316, 454
Crotonopsis linearis ... 454
Crow-foot grass ... 414
Cruciferae ... 462
Crypsinna stricta ... 262
Crystalina ... 230
Ctenium americanum ... 406
Cucumber ... 347, 465, 466
  tree ... 482
Cucurbita ficifolia ... 223
  foetidissima ... 121, 236
  radicans ... 121
Cucurbitaceae ... 114, 115, 223, 236, 251, 318, 462, 542
Cudrado ... 213
Cultural plant formations ... 410–414
Cultivated plants of Ocracoke Island ... 275
Cuphea cristata ... 196
  empetrifolia ... 137
  graciliflora ... 196, 197
  hookeriana ... 137
  koehneana ... 197
  llavea ... 145
  nelsoni ... 137
  nudicostata ... 197
  pinetorum ... 197
  trichopetala ... 196
Currant ... 80, 92, 97
Currants, wild ... 471, 528
Cuscuta arvensis ... 460, 538
  gronovii ... 435, 437, 538
Cuscutaceae ... 462, 538
Cushion form of plants ... 386
Cyclanthera eremocarpa ... 121
  langaei ... 122
  micrantha ... 122
  monosperma ... 120
  pringlei ... 122
  ribiflora ... 122
Cynanchum palustre ... 456
Cynoctonum mitreola ... 274, 317, 455
  sessilifolium ... 455, 537
Cynodon dactylon ... 270, 315, 395, 472
Cynoglossum virginicum ... 539
Cyperaceae ... 92, 301, 315, 393, 461, 462, 517
Cyperus ... 377, 461
  baldwinii ... 315
  compressus ... 452
  cylindricus ... 315, 379, 387, 452, 517
  echinatus ... 315, 459
  erythrorhizos ... 440, 441, 517
  esculentus ... 459, 517
  filiculmis ... 517
  flavescens ... 459, 517
  flavicomus ... 450, 452, 517
  grayi ... 377, 379, 382, 387, 452, 517
  haspan ... 378, 439, 449, 452, 459, 517

Page.
Cyperus microdontus 452, 517
nuttallii 319, 517
ovularis 517
pseudovegetus 406, 439, 451, 517
retrofractus 517
rotundus 414, 472, 517
speciosus 315
stenolepis 452
strigosus 518
tetragonus 452
torreyi 315
Cypress 334, 335, 337, 355, 418, 420, 421, 425, 429, 433, 434, 436, 479, 481, 483, 520, 540
bald 417, 418, 433, 443
blown-down, in Dismal Swamp 342
stumps, Dismal Swamp 340, 418
trees in sand dunes 334
Cypripedium acaule 450, 522
Cyrilla 458
racemiflora 454, 532
Cyrillaceae 532
Cystopteris fragilis 148

D.

Dactylis 412
glomerata 412, 469, 516
Dactyloctenium aegyptiacum 414, 516
Daisy, white 472
Damiana 230
Danthonia 405
californica 36
intermedia 36
sericea 380, 401, 451, 516
spicata 401, 516
Dark swamp 417-423
Dasylirion spp 224, 240
Dasystoma 458
flava 540
Date palm 214
Datura 543
stramonium 540
tatula 230, 318, 414, 540
Daucus carota 408, 414, 535, 541
Deciduous forest 418, 419, 422
trees of Cœur d'Alenes 33, 55
Decodon 458
verticillatus 428, 437, 440, 443, 534
Decorative plants 256
Decumaria 421, 458
barbara 416, 421, 449, 454, 485, 491, 527
Delphinium 157
gracillimum 157
Dendrium buxifolium 455
Deschampsia atropurpurea 36
caespitosa 35
elongata 35
"Desert," Dismal Swamp region 333, 334, 335
Desmodium 380
paniculatum 316
strictum 382
Dewberry 375, 470, 471, 479
Devil's shoestring 541
Dianthera americana 437, 538, 541
ovata 456
Dichondra evolvulacea 456, 459, 538
Dichromena colorata 274, 315, 406, 452, 518

Page.
Dichromena latifolia 452
leucocephala 274, 315
Dicotyledones 522
Dicranum flagellare 511
scoparium 511
Digitaria fimbriata 315
Diodia teres 272, 276, 318, 375, 376, 382, 385, 388, 456, 541
virginiana 274, 276, 318, 378, 394, 456, 541
Dionaea muscipula 454
Dioscorea convolvulacea 236
sp 236
villosa 416, 522
Dioscoreaceae 236, 462, 522
Diospyros 405
ebenaster 223
virginiana 372, 373, 378, 382, 394, 399, 400, 407, 471, 472, 477, 479, 482, 537
Diploptychia 137
Discopleura 458
Dishcloth 249
Dismal Swamp, area 339
canal 34, 339, 356
cause of its existence 339
depth of water 341
description 341
early survey 341
elevation 339
location 339
Dismal Swamp plants, anatomy 484-509
region, aquatic plants 443-447
bibliography 547-550
botanical survey 321-550
cleared land formations 406-414
climate 324-330
cultivated plants 410-414
drainage 322, 339, 347, 353-356, 358, 395, 474
families of plants 461
field crops 411, 412, 467-471
forest fires 415, 416
forest formations 396-408
fresh-water formations 417-447
fresh-water marsh formations 430-440
frosts 328
genera, endemic 459
genera, monotypic 458, 459
genera, nonendemic 459
geography 331-342
geology 342-344
hygrophile forests 417-436
introduced plants 461
lianas 416, 420
life zones and areas 447-450
list of plants 509-547
location and extent 331
maritime plant formations 360-395
nonhygrophile inland formations 395-416
northern limits of species 450-457
peat deposits 342, 350, 351, 423, 424
physiography 331-342
phytogeographical affinities 447-463
plant formations 350-447
rainfall 328, 329, 357
relation of plants to soils 473-484

Page.

- Dismal-Swamp region—Continued.
    - salt marshes 337, 338, 344
    - salt-marsh plants 364–367
    - sand dunes 333–337, 368–381
    - soils 322, 344–358, 404, 405, 429, 430, 463–466, 473–484
    - southern limits of species 449, 450
    - strand plant formation 367–395
    - swamps 338–342, 417–429
    - temperature 324, 325
    - "The Desert" 333, 334, 335
    - "The Plain" 338, 342, 345–349
    - The Strand 345, 346
    - truck crops 345–349, 463–467
    - truck soils 463–466, 473–484
    - trucking 345–349, 354, 411, 463–467
    - wind records 330
    - wooded swamps 349–358
- Distichlis 458
    - *maritima* 273, 315
    - spicata 273, 313, 315, 516
- Dock 95, 413, 414
- Doellingeria humilis 457
- Dog fennel 408, 413, 414, 472
- Dogwood 398, 400, 473, 478, 482, 483, 484
    - poison 480
- Doryanthes 153
- Douglas spruce 43, 58, 59, 60, 63, 66, 68, 74, 75
- *Doyerea emetocathartica* 121
- Drainage in Dismal Swamp region 322; 347, 474, 353–356, 358
    - influence on distribution of plants 395
    - of part of Dismal Swamp 339
    - system of Cœur d'Alenes 10–13
- Drinking cups, gourds, and flasks 259
- Drosera brevifolia 454
    - filiformis 454
    - intermedia 378, 460, 527
- Droseraceae 462, 527
- Dry land formations 485
- Drymaria 131
    - confusa 133
    - gracillima 132
    - nodosa 131, 132
    - *nodosa gracillima* 132
    - tenella 131, 132, 133
- Dryopteris 146
    - *acrostichoides* 402
    - ampla 147
    - contermina 147
    - goldieana celsa 512
    - marginalis 512
    - martinicensis 147
    - noveboracensis 512
    - parasitica 147
    - patula 148
    - patula chaerophylloides 148
    - spinulosa 460, 512
    - spinulosa dilatata 450, 512
    - thelypteris 512
- Duchesnea indica 528
- Dugouts 89
- Dulce 218
- Dulichium 458
    - arundinaceum 438, 518
- Dune formation 269, 270

Page.

- Dune marshes, Dismal Swamp region 378
- Dune-marsh formation 374
- Dunes, Dismal Swamp region 333–337
    - inner, wooded, or gray 367, 378–381
    - middle 368, 370–378
    - open, white, or sea dunes 368, 370
- Dupatya flavidula 453
- Dwarf spruce pine 484
- Dye and tanning plants of Mexico 237
    - made from alder bark 94

E.

- Early Rose potatoes 466
- Eatonia 458
    - nitida 516
    - obtusata 35, 516
- Ebenaceae 223, 462, 537
- Echinocystis 114, 115, 119, 120
- *Echinocystis* 115, 117
    - araneosa 119
    - *bigelovii* 120
    - *brandegei* 119
    - *coulteri* 116, 117
    - *floribunda* 116
    - gemella 119
    - glutinosa 119
    - *lanata* 117
    - *longispina* 117
    - *milleflora* 117
    - muricata 119
    - paniculata 119
    - *parviflora* 120
    - polycarpa 119
    - *pubescens* 118
    - *torquata* 118
    - *wrightii* 118
- Echinodorus radicans 518
- Echinopepon 114, 115, 118, 119, 120
    - cirrhopedunculatus 115
    - confusus 115, 116
    - coulteri 116
    - floribundus 116
    - horridus 115, 116
    - jaliscanus 117
    - lanatus 117
    - longispina 117
    - milleflorus 115, 117
    - minimus 117
    - nelsoni 117
    - parvifolius 118
    - pringlei 117
    - pubescens 118
    - quinquelobatus 115
    - torquatus 118
    - wrightii 116, 118
    - *bigelovii* 119, 120
    - *coulteri* 116
    - *horridus* 116
    - *insularis* 119, 120
    - *palmeri* 119, 120
    - *parviflorus* 119, 120
    - *quinquelobatus* 118
- Eclipta alba 414, 546
- Eggplant 466
- Elaphrium submoniliforme 114
    - *bicolor* 113

Page.
Elaphrium *lanuginosum* 114
ovalifolium 114
Elaterium 120
bigelovii 120
ciliatum 122
coulteri 116, 118
longisepalum 122
minimum 117
pubescens 118
ribiflorum 122
torquatum 118
wrightii 118
Elder 59, 104, 407, 429
Elecampane 108
Eleocharis 274, 437
albida 452
capitata 452
engelmanni 518
glaucescens 518
melanocarpa 452
microcarpa 452
mutata 393, 439, 460, 518
ochreata 452, 460, 518
ovata 439, 518
palustris glaucescens 393
prolifera 452, 518
sp 315
tenuis 518
tortilis 406, 439, 452, 518
tricostata 452
tuberculosa 452, 518
Elephantopus 380
nudatus 318, 402, 405, 456, 543
tomentosus 543
Eleusine indica 315, 414, 516
Elm, American 399
slippery 482
Elms 473, 483
Elodea 458
Elodes 458
Elymus condensatus 35, 91
glaucus 35
virginicus 517
Embryophyta 458, 461, 512
Embryophytes 444, 459
Enchalada 236
Endemic genera 459
Engelmann's spruce 43, 47, 55, 59, 60
Entada polystachya 235, 236
Enterolobium cyclocarpum 228, 235, 236, 238
Entomophilous pollination 393
Epicampes macroura 252
sp 256
Epigaea 458
repens 536
Epiphytes 402, 421, 436, 440
Equisetaceae 88
Equisetum hyemale 88
Eragrostis hirsuta 451, 516
major 516
nitida 315, 451
pectinacea 394, 516
pilosa 516
refracta 378, 394, 451, 516
Erechtites 380
hieracifolia 318, 416, 490, 547

Page.
Erianthus 314
compactus 451
contortus 409, 410, 451, 513
saccharoides 437,
438, 439, 440, 442, 449, 451, 460, 513
Ericaceae 102, 422, 436, 461, 462, 499, 502, 536
Erigeron 472
annuus 545
canadensis 318, 377, 378, 387, 409, 414
linearifolius 415
pulchellus 545
quercifolius 457
ramosus 545
beyrichii 545
vernus 457, 545
Eriocaulaceae 462, 520
Eriocaulon compressum 453
decangulare 437, 453, 520
Eriodendron tomentosum 180
Eriogonum elatum 95
stellatum 95
tomentosum 453
Eriophorum virginicum 428, 518
Eryngium virginianum 455, 535
Erythrina flabelliformis 255
herbacea 454
lanata 255
spp 255
Esblichia odorata 165
Esenbeckia 110
acapulcensis 111
berlandieri 110, 111
flava 110, 111
hartmanii 110, 111
litoralis 111
macrantha 111
Espinocilla 230
Estoca banco 244, 248
Estropajos 251
Etonia scrub formation 434
Euagave 224
Euonymus 458
americanus 532
Eupatorieae 461
Eupatorium 314, 380, 400
album 543
aromaticum 456, 543
capillifolium 377,
394, 408, 409, 413, 414, 449, 457, 460, 472, 543
coelestinum 402, 543
coronopifolium 457
foeniculaceum 377
hyssopifolium 457, 544
leucolepis 457
linearifolium 405, 409, 543
maculatum 543
perfoliatum 543
pinnatifidum 406, 457, 543, 544
pubescens 543
purpureum 453, 543
rotundifolium 378, 405, 406, 409, 457, 540, 544
semiserratum 402, 457, 544
serotinum 402, 457, 544
sp 402, 405, 544
torreyanum 457
verbenaefolium 457, 544

Page.
Euphorbia curtisii ... 454
  ipecacuanhae ... 454, 532
  maculata ... 532
  nutans ... 532
  polygonifolia ... 270, 276, 279, 280, 313, 316, 370, 376, 382, 385, 391, 532
  sp ... 229
Euphorbiaceae .. 227, 229, 235, 253, 257, 316, 462, 531
Euthamia ... 458
  caroliniana ... 318, 457, 545
Euwaltheria ... 183
Evening primrose ... 100
Evergreen-tree formations ... 271
Evernia vulpina ... 88, 92
Exobasidium discoideum ... 510

F.

Faba vulgaris ... 213
Fagaceae ... 94, 316, 461, 462, 523
Fagara pterota ... 112, 164
Fagopyrum fagopyrum ... 525
Fagus ... 404, 458, 520
  americana ... 398, 404, 405, 407, 426, 523
  castanea ... 482
  sylvatica ... 482
Falcata ... 458
  comosa ... 416, 530
Families, genera, and species of Dismal Swamp, distribution ... 462
  prominent in Dismal Swamp ... 461
Fence plants of Mexico ... 253, 255
  posts ... 52, 55
  rails ... 46
Fennel ... 414
Fern and Peat Moss association ... 428
  large ... 428
Ferns ... 146, 314, 402, 417, 421, 428, 435, 440
  collected in Mexico ... 146–151
  forest ... 423
  tree ... 436
Fertilizers used on truck soils ... 347
Fescue grass, red ... 382
  meadow ... 412, 469
Festuca ... 58
  elatior ... 412, 469, 517
  myurus ... 408, 517
  octoflora ... 387, 408, 517
  rubra ... 35, 36, 382, 386, 449, 460, 517
    glaucescens ... 449
  scabrella ... 36
  sciurea ... 517
Fiber plants of Mexico ... 239–253
  products ... 249
  working implements ... 248–251
Ficus carica ... 275, 316, 413
Field crops, Dismal Swamp region ... 410–412
  peas ... 468
Fierro tallador ... 244
Fig ... 214, 275, 412, 413, 470
Filices ... 228
Fimbristylis autumnalis ... 378, 439, 460, 518
  castanea ... 452, 460
  laxa ... 439, 460, 518
  spadicea ... 274, 279, 313, 315, 363, 366, 378, 449, 452, 460, 518
  vahlii ... 452
Fir ... 43, 48, 60, 68
  balsam ... 49
  Oregon ... 43
  red ... 31, 43, 48
  subalpine, in Cœur d'Alenes ... 43, 49, 56, 59, 60, 68, 69, 77
  white, in Cœur d'Alenes ... 31, 43, 48, 49, 58, 59, 70, 88
Fire blocks ... 88
  blower ... 241
Fireweed ... 416
Firewood ... 255
Fish nets ... 99
  poison ... 257
Flag, sweet ... 30
Flavoring p'ants ... 226, 227
Flax, Rocky Mountain ... 92, 99
Floor mats ... 240
Flor de venodillo ... 229
Flowering shrub ... 97
Fly brushes ... 240, 252
Foeniculum foeniculum ... 414, 535
Fogs in Cœur d'Alenes ... 20
Forage plants, Dismal Swamp region ... 412, 463, 468, 469
Forest classification, Cœur d'Alenes ... 56
  destruction by farmers ... 71, 80
    by fire ... 62–74
    by lumbering ... 65, 66, 79
    by railroads ... 62, 70, 80
    by wind ... 64
    effects ... 75–78
    in Cœur d'Alenes ... 3, 61–75
  fires, burned areas ... 71–75
    in Cœur d'Alenes ... 3, 51, 62–71
    in Dismal Swamp region ... 415, 416
  formations ... 396–406, 485
  inland, Dismal Swamp region ... 396–406
  mixed, Dismal Swamp region ... 396–405
  preservation in Cœur d'Alenes ... 75–85
  protection, system proposed ... 79–85
  renewal, in Dismal Swamp region ... 397
  reserves ... 79
  resources of Cœur d'Alenes ... 42–55
  zones, Cœur d'Alenes ... 56–61
Forests, influence on climate ... 75–78
  influence on water supply ... 76–78
  yield per acre of timber ... 74, 75
Fothergilla carolina ... 454
Fouquieria spinosa ... 255
Foxtail, yellow ... 472
Fragaria ... 458
  virginiana ... 98, 471
    australis ... 528
Fraxinus ... 458
  alba ... 482
  caroliniana ... 419, 420, 449, 455, 460, 481, 537
  cerulea ... 482
  nigra ... 482
Fresh-water formations ... 485
    marsh formations ... 436–440
Frijol ... 212, 213
  apasteado ... 212
  blanco ... 212
    nallado ... 213
  cando ... 213

Page.
Frijol encrevado 213
  garvanode picachos 213
  guero 213
  hortelano 212
  lavareno 213
  mesquitillo 213
  mexicano 213
  morado bola 213
  negro 213
  nuevo tempranillo 213
  sequin 213
Fringe tree 429
Frosts in Cœur d'Alenes 20
    Dismal Swamp region 326
Fruit trees, Dismal Swamp region 412
Fruits 214-223
  of Dismal Swamp region 463, 470, 471
    Mexico 214-223
Fuirena squarrosa 406, 439, 452, 518
  hispida 452
  hygrometrica 440, 511
  calvescens 511
Fungi 59, 314, 275, 510
  attacking forest trees 65
  leaf 314
  parasitic leaf 402
  saphrophytic 395, 401, 403, 421
Furcraea 153

G.

Galactia 402
  acapulcensis 137
  glabella 137
  marginalis 136
  pilosa 273, 316
  regularis 454, 530
  sessiliflora 454
  volubilis 273, 279, 316, 405, 408, 416, 530
Galieae 506, 507
Galium 318, 506
  aparine 541
  circaezans 542
  claytoni 380, 542
  claytoni 318
  hispidulum 379,
      382, 384, 389, 390, 456, 485, 488, 506, 507, 542
  pilosum 542
  tinctorium 318
    trifolium 456, 542
Gallberry 400, 466, 477, 479
  land 347, 467, 468
Galphimia glandulosa 137
Garambullo 229
Garden vegetables 30, 31, 38, 210, 213, 275, 463
    of Dismal Swamp region 410, 411
Garrigues 272
Garvancillo verde 213
Garvanzo de picachos 213
Gauge 141
Gaultheria procumbens 421, 450, 536
Gaylussacia 458
  dumosa hirtella 455
  frondosa 401, 404, 471, 476, 477, 479, 537
  resinosa 471, 537
Gelsemium 375, 394, 401, 404, 405, 408, 421, 458, 505
Gelsemium sempervirens 375, 380,
    389, 390, 393, 401, 404, 407, 416, 420, 432,
    433, 449, 455, 460, 477, 479, 485, 505, 537
Genera, endemic 459
  monotypic 458, 459
  nonendemic 459, 460
  number, Dismal Swamp region 461
Gentiana elliottii 402, 456, 538
  porphyrio 456
Gentianaceae 462, 538
Geraniaceae 462, 531
Geographical affinities of flora 312
Geography of Dismal Swamp region 331-342
Geology of Cœur d'Alenes 9
    Dismal Swamp region 342-344
    Ocracoke Island 287
Geranium carolinianum 531
Gerardia 314, 458, 540
  divaricata 540
  linifolia 456
  maritima 318
  purpurea 440, 540
  tenuifolia 540
Gerardieae 461
German millet 412, 469
Geum 458
  canadense 528
Gilia aggregata 103
Glasswort 362
Gleditsia triacanthos 482
Glyceria 450
  fluitans 86
  nervata 86
Gnaphalium helleri 546
  purpureum 318, 376, 386, 460, 546
Golden rods 409
Gonolobus 458
Gonolobus 416
Gooseberry 80, 97
Goosefoot 95
Gordonia lasianthus 454
Gossypium barbadense 180, 251
  herbaceum 235, 317
  spp 235, 236
Gouania pallida 138
  stipularis 138
Gobernadora 229
Gordo 211
Gourd, wild 121
Gourds 259
Gramineae 279, 301, 393, 461
Granadilla 142
Grape 374, 470, 477
  muscadine 375, 407, 420, 470, 471, 477, 479
  Oregon 97
  summer 375
Graphephorum wolfii 85
Grasper 244, 248
Grass roots 252
Grasses in forest areas 401
    pine barrens 405
  of Cœur d'Alenes 85, 86
Gratiola pilosa 405, 456, 540
  sphaerocarpa 440, 456, 540
  virginiana 440, 540
Gratioleae 461

Page.
Grazing lands in Cœur d'Alenes 31-34
Greenbrier 407, 427, 477
  laurel-leaved 480
  round-leaved 479
Gronovia longiflora 197
Ground nut 421
Guaiacum coulteri 255
Guapilla 243, 245
Guava 221
Guayaba 221
Guayacan 255, 256
Guazuma ulmifolia 256
Guilandina bonducella 374
  dioica 482
Gum 314, 334, 482, 536
  black 334, 399, 404, 417, 418, 419, 420, 421, 422, 423, 424, 426, 427, 429, 435, 479, 480, 481, 483, 527, 536
  cotton 426, 479
  papaw 419, 536
  sour 476, 477
  sweet 338, 396, 399, 400, 404, 407 419, 476, 477, 478, 482, 483
Gymnogramme japonica 139
  subcordata 138
Gymnopogon ambiguus 408, 451, 516
  brevifolius 451
Gymnospermae 512
Gyrostachys cernua 522
Gyrotheca capitata 453
  gracilis 522
  odorata 453, 522
  praecox 453, 522

H.

Haba 257
Habenaria 314
  blephariglottis 406, 522
  clavellata 421, 522
  cristata 406, 429, 453, 522
  integra 453
  nivea 453
Habilla 257
Hachogue 236
Hackberry 399, 471, 482, 483, 537
Haematoxylon boreale 237
  campechianum 238
Hair brushes 252, 253
Halophile plants 360
Halophytic plants 360
Haloragidaceae 462, 535
Hamamelidaceae 462, 490, 527
Hamamelis 458, 490
  virginiana 404, 527
Hammock 484
  clay 484
  flat 484
  high 484
  marl 484
Hand bags 242, 249
Harotaga 496
Hassock form of plants 386
Hats made of bark 94
Hats, palm-leaf 239, 240
Hava 213, 257
Haws 482
Hay 29, 31, 32, 33, 35, 36, 37, 469
Hazlenut 94
Hedge plants of Mexico 253-255
Hedwigia 510
Heleastrum paludosum 545
Helenium vernale 457
Helianthemum canadense 382, 388, 389, 401, 485, 497, 498, 533
  corymbosum 455
Helianthus 314, 458
  angustifolius 457, 546
  atrorubens 402, 404, 546
Heliocarpus 125
  americanus 125, 126, 128
  americanus 128
    popayanensis 125
  appendiculatus 126
  arborescens 126
  attenuata 128
  glanduliferus 127
  nelsoni 128
  nodiflorus 126, 127
  occidentalis 127
  pallidus 128
  palmeri 126, 128
  polyandrus 126, 127
    nodiflorus 126, 127
  popayanensis 125
  reticulatus 128
  tomentosus 126
  tomentosus 128
  trichopodus 125, 126
Hemerocallis fulva 521
Hemicarpha micrantha 452
Hemlock 43, 48, 68, 70, 536
  Mertens's 43, 53, 54, 55, 63, 68
  Patton's 43, 53, 54, 60
  spruce 43, 50, 55
  water 101
Hemp, sisal 239, 243
  Tampico 210, 242, 244
Hepaticae 314, 402, 510
Heracleum lanatum 102
Herbaceous plants 423, 435, 485
Hermannia 130
  inflata 130
  palmeri 131
  pauciflora 131
  texana 130, 131
Herpestis monniera 274, 305, 318, 363, 366
Hesperogenia 203
  stricklandi 203
Heteropterys acapulcensis 139
Heterosicyos 115, 121
Heterotheca subaxillaris 457
Hibillo 257
Hibiscus biseptus 174
  coulteri 174
  manihot 174
  moscheutos 317, 364, 366, 533
  rosa-sinensis schizopetalus 175
  sabdariffa 225
  schizopetalus 175
  sp 175
Hickory 473, 479, 483, 484
  mockernut 407

Page.
Hickory scurfy 390
Hicoria 458
  alba 398, 407, 523
  aquatica 453
  carolinae-septentrionalis 453
  glabra 382, 399, 523
  microcarpa 523
  villosa 399, 405, 523
Hieracium gronovii 318, 543
  sp 231
  venosum 402, 543
Highland pine 484
Higuerilla 235, 237
Hikora 258
  sunama 258
  wanami 258
Hinseseli 230
Hippocratea acapulcensis 109
  mexicana 110
  pauciflora 197
  sp 253, 255, 256
  uniflora 110
  utilis 197
Hiraea parviflora 139
  polybotrya 139
  polybotrya 139
Hirtella polyandra 196
Hogweed 408, 472
Holcus lanatus 402, 516
Holly 373, 398, 425, 477, 479, 483
Holly-leaved buck brush 32, 59
Holodiscus discolor 58
Homalocenchrus hexandrus 451
  oryzoides 440, 460, 515
  virginicus 315, 515
Honey locust 482
Honeysuckle 400, 414
Honkenya 368, 382, 458
Hordeum pusillum 413, 414, 472, 517
Horse nettle 414
    prickly 473
Horsetooth corn 467, 481
Horseweed 413, 414, 472
Horsfordia newberryi 180
Hortus cliffortianus 125
Hottonia inflata 455
Houstonia 458
  caerulea 408, 541
Huamuchil 216
Huckleberry 38, 60, 89, 103, 471, 476, 477, 479
Hudsonia 386, 394, 458
  ericoides 497
  tomentosa 375, 377,
      382, 386, 388, 389, 394, 449, 485, 496, 497, 533
Hudsonian zone 447
Huila 224, 247, 249
Huinecastle 228, 235, 236
Hura crepitans 257
Huts, material 240
Hydrochloa fluitans 451
Hydrocotyle canbyi 455
  ranunculoides 440, 459, 535
  umbellata 274, 317, 378, 435, 437, 440, 459, 535
  verticillata 455, 535
Hygrophile forest, Dismal Swamp 329, 417
Hymenocallis sp 145

Page.
Hypericaceae 317, 462, 495, 496, 533
Hypericum 314, 495
  adpressum 454
  aspalathoides 454
  densiflorum 454
  fasciculatum 454
  galioides 406, 454, 533
  mutilum 533
  perforatum 533
  pilosum 406, 455, 485, 495, 496, 533
  virgatum 406, 455, 485, 495, 533
Hypnum boscii 511
  cupressiforme 511
  spp 511
Hypoxis hirsuta 402, 522

I.

Ilex 272, 277, 279, 490
  ambigua 454
  aquifolium 297, 492, 493
  caroliniana 532
  cassine 270, 317
  decidua 426, 454, 532
  glabra 317, 400, 404, 426, 431,
      432, 433, 454, 477, 479, 485, 492, 493, 532
  lucida 426, 431, 432, 433, 454, 485, 493, 532
  opaca 297, 317, 373, 379, 398,
      404, 419, 426, 432, 477, 479, 492, 493, 532
  pseudothea 492
  verticillata 532
  vomitoria 270, 271, 272, 278, 279, 280,
      281, 296, 299, 300, 313, 317, 386, 454, 492
Ilicaceae 317, 462, 492, 532
Ilysanthes attenuata 440, 540
  gratioloides 405, 440, 540
Impatiens biflora 428, 532
Impatientaceae 462, 532
Indian arrow 251
  corn 210, 411, 412
Indigofera caroliniana 406, 454, 529
  cuernavacana 140
  fruticosa 140
  palmeri 140
  salmoniflora 140
Inland formations 485
Insect attacks on white pine 45
Introduced plants, origin 461
Inula helenium 106
Ionactis 458
  linariifolius 408, 545
Ipazote del zorillo 228
  skunk 228
Ipomoea hederacea 472, 536
  pandurata 536
  pes-caprae 368, 385
  purpurea 414, 472, 536
  quamoclit 536
  sagittata 274, 313, 317, 456
Iridaceae 93, 462, 522
Iris 145, 442, 458
  caroliniana 437, 442, 453, 522
  missouriensis 93
  verna 408, 522
Irrigation in Cœur d'Alenes 40-42
Isnardia palustris 445, 446, 490, 534
Isote 241, 253

Page.
Istle 244
Itea 426, 458, 490
  virginica 426, 436, 454, 485, 490, 527
Iva 458
  frutescens 273, 283, 308, 310, 311, 312, 313, 318, 363, 366, 456, 485, 543
  imbricata 308, 368, 370, 382, 384, 391, 392, 393, 394, 456, 485, 543
Ivy, poison 375, 421
Ixtle 243, 244
  fiber 244, 248

J.

Jabo 220
Jamaica 225
Japan clover 408, 468
Jatropha curcas 229, 253, 255
  platyphylla 254
  spathulata occidentalis 238
  stimulosa 382, 402, 405, 449, 454, 532
Javilla 257
Jericho Canal, Dismal Swamp region 341
Jessamine, yellow 375, 407, 420, 477, 479
Jimson weed 414, 543
Juglandaceae 462, 527
Juglans 458
  nigra 399, 479, 523
  oblonga 482
Juncaceae 82, 301, 315, 393, 461, 462, 520
Junci 440
Juncoides campestre 460, 521
  pilosum 450, 521
Juncus 273, 363, 442
  acuminatus 439, 520
    debilis 439, 440, 521
  balticus 92
  canadensis 437, 439, 440, 521
  dichotomus 274, 315, 378, 521
  effusus 437, 521
  marginatus 439, 521
    aristulatus 521
  polycephalus 453
  repens 435, 439, 440, 445, 446, 453, 460, 521
  roemerianus 272, 273, 276, 279, 282, 283, 301, 310, 311, 312, 313, 315, 362, 366, 367, 453, 485, 521
    association 273, 359, 362, 363, 364
  scirpoides 274, 315, 378, 453, 521
  setaceus 406, 439, 453, 521
  tenuis 521
Juniper 43, 340, 350, 355, 417, 422, 423, 424, 425, 426, 434, 479, 480, 483, 512
  alpine 43
  bays 483
  forest association 423
  land, character 350
  light, or open swamp 417, 423–429
  mountain 43, 55
  peat 424
  reproduction 425
  swamp, Dismal Swamp region 350, 423–429
Juniperus 458
  nana 43, 55
  occidentalis 88
  virginiana 43, 55, 270, 271, 314, 378, 399, 405, 407, 477, 512
Jussiaea 433
  decurrens 440, 455, 535
  grandiflora 455

K.

Kale 411, 464
Kalmia 458, 502
  angustifolia 426, 431, 433, 485, 502, 536
  hirsuta 455
  latifolia 400, 404, 521, 536
Karwinskia humboldtiana 229
Kieffer pear 470
Klamath Indian plant names 107
  Indians, plants used 87
Knees on cypress roots 420, 433
Kneiffia longipedicellata 535
Knotweed 414
Koellia 458
  aristata 456
  hyssopifolia 402, 405, 456, 539
  mutica 402, 539
Kosteletzkya 458
  altheaefolia 454
  paniculata 180
  virginica 274, 279, 280, 282, 303, 310, 311, 312, 313, 317, 364, 366, 454, 485, 533
Kraunhia frutescens 454
Krigia 458
Kunzia tridentata 98
Kyllinga pumila 518

L.

Labiatae 230
Lachnocaulon anceps 453, 520
Lacinaria 314, 458
  elegans 457
  graminifolia 406, 457
    pilosa 457, 544
  tenuifolia 457
Lactuca sagittifolia 543
Ladles, wooden 256
Lady cowpea 469
Lagenaria sp 259
Lagerstroemia indica 413
L'aguapan 257
Lake Drummond, altitude 339
    character of water 355
    description 339–341
Lamb's quarters 95, 414
Lamium amplexicaule 539
Lantana sp 230
Larch, western 43, 59
Larches 43
Larix occidentalis 31, 43, 50
Lauraceae 215, 226, 228, 462, 489, 526
Laurel 226, 228, 400, 426
  oak 379, 398, 400
Laurel-leaved greenbrier 480
Laurus nobilis 489
  sassafras 482
Leaf anatomy, sand-strand plants 299
Leaf structures described 484–509
  peculiarities 430–432
Leaves of strand plants, peculiarities 388–391
Lechea 386, 458
  leggettii 534

Page.
Lechea major 497
  major 317
  maritima 375, 377, 382, 385, 388, 389, 390, 393, 449, 485, 496, 497, 498, 534
  minor 497, 534
  novae-caesareae 497
  villosa 317, 534
  racemulosa 534
Lechuguilla 231, 237, 241, 242, 244, 248
Leersia virginica 315
Legouzia perfoliata 542
Legumes 412
Leguminosae 216, 228, 235, 237, 380, 382, 385, 402, 405, 421, 468
  new or rare 191-195
Leichtlinia 156
Lemnaceae 462, 520
Lemons 214
Lengua de cervo 228
Lentibulariaceae 462
Lepidium virginicum 414, 460, 527
Lepigonum salinum 274
Leptilon canadense 413, 460, 472, 545
Leptodon trichomitrion 511
Lespedeza 380, 402, 405, 408, 468
  angustifolia 454
  capitata 530
  hirta oblongifolia 454
  procumbens 530
  striata 408, 468, 530
  stuvei neglecta 530
  virginica 530
Lettuce 411, 464, 466
Leucaena microcarpa 141
  glabrata 140
  glauca 140
  sp 229
Leucobryum albidum 511
  glaucum 511
  minus 511
Leucodon brachypus 511
  julaceus 511
Leucothoë 426
  axillaris 404, 422, 426, 431, 432, 433, 449, 455, 485, 499, 500, 536
  catesbaei 499, 500, 536
  recurva 500
  racemosa 400, 426, 433, 455, 485, 500, 536
Lianas ... 271, 382, 400, 403, 406, 407, 416, 421, 426, 436
Lianas, clambering 416
  classification 416
  climbing 416
  Dismal Swamp region 416, 420
  in forests 401, 403
  twining 416
  woody 373
Liatris 314, 458
Libocedrus decurrens 88, 89
Licania arborea 234, 237
Lichen 38, 87, 88, 92, 271, 272, 402, 421
Lichenes 87, 314, 395, 510
Lichens of sand strand 395
Life zones 447
Light, or open, swamp 417, 423-429
Lightning as a cause of forest fires 65
Lilaeopsis lineata 455
Liliaceae 93, 228, 232, 240, 315, 316, 462, 531
Lilium 458
  catesbaei 453
  superbum 429, 435, 521
Lily family 37
  water 96, 444
Lima beans 411
Lime juice 225
  in soil, effect on vegetation 474
  used on swamp soils 347, 348, 352
Limes 214, 224
Limnanthemum aquaticum 456
Limnophile plants 380
Limodorum 458
  pauciflorum 453
  tuberosum 428, 435, 440, 522
Limonium carolinianum 313, 317, 363
Linaceae 99, 462, 531
Linaria 408
  canadensis .. 376, 386, 388, 394, 402, 408, 460, 540
Linum floridanum 402, 406, 531
  medium 316, 402, 531
  striatum 531
  virginianum 531
  lewisii 92, 94, 99
Lippia 226, 227, 274
  berlandieri 227
  lanceolata 539
  nodiflora 274, 276, 279, 282, 283, 304, 310, 311, 312, 313, 317, 452
  palmeri spicata 227
  purpurea 227
  sp 363, 366, 539
Lipocarpha maculata 439, 452, 518
Liquidambar 396, 400, 403, 404, 405, 407, 458, 460, 511
  styraciflua 398, 407, 419, 433, 476, 478, 482, 485, 490, 527
Liriodendron 401, 404, 405, 458
  tulipifera 398, 407, 418, 477, 482, 526
Listera australis 453
Litsea glaucescens 226, 227
Live oak 271, 276, 372, 378, 387, 389, 412, 483
Liverworts 59, 421
Lizard's tail 433
Loasaceae 100
Lobelia 98
  amoena 456
    glandulifera 456
  canbyi 456
  cardinalis 542
  glandulosa 456, 542
  inflata 542
  nuttallii 542
  paludosa 456
  puberula 402, 542
Lobeliaceae 462
Loblolly pine 373, 380, 482
Locust, black 380
  honey 482
Lodge-pole pine 87, 89, 104
Loeselia coccinea 230
  sp 230
Loganiaceae 317, 462, 537
Logging and milling in Cœur d'Alenes ... 66
Logwood 228
Lolium perenne 412

Page
Longleaf pine.................... 406, 482, 483, 484
Lonicera.................................. 375
  conjugialis.............................. 104
  japonica 414, 542
  sempervirens........................... 375,
      389, 390, 393, 394, 401, 416, 485, 507, 508, 542
Lophiola americana....................... 453
Lophophora williamsii..................... 258
Loranthaceae.......................... 524, 462
Lotus, yellow.............................. 444
Low marsh 485
    formation.......................... 439, 440
Lower Austral zone................ 447, 448, 449
  Sonoran area 447
Ludwigia alata 274, 317, 455, 534
  alternifolia 440, 535
  capitata................................. 455
  glandulosa..................... 443, 455, 535
  hirtella 455
  linearis 440, 443, 455, 535
  microcarpa 274, 317, 455
  palustris 445
  pilosa 443, 455, 535
  sphaerocarpa 455
  virgata........................... 406, 455, 535
Luffa cylindrica........................... 251
  operculata............................... 122
    intermedia............................ 122
Lumber... 44, 46, 48, 50, 51, 52, 54, 55, 62, 66, 72, 75, 89
Luzula 450
Lychnis drummondii 141
  mexicana 141
Lycopersicum esculentum.................. 318
Lycopodiaceae 462, 512
Lycopodium alopecuroides 512, 406, 451
  carolinianum 451
  inundatum..................... 378, 460, 512
Lycopus.................................... 435
  europaeus........................... 414, 539
  rubellus 423, 435, 539
  virginicus.............................. 539
Lyonia 458, 501
  paniculata 501
Lysiloma candida 238
Lysimachia angustifolia 537
  quadrifolia 537
  terrestris 537
Lythraceae 317, 443, 462. 534
Lythrum lineare 363, 366, 455, 534

M.

Macbridea pulchra 456
Madia glomerata 106
Madroño wood 256
Magnolia 228, 419, 458, 483, 484
  acuminata 482
  conspicua 488
  glauca.................. 480, 483, 485, 488, 489
  grandiflora 488
  tripetala 489
  umbrella 489
  virginiana 335,
      419, 425, 431, 432, 433, 436, 453, 526
Magnoliaceae.................. 228, 462, 488, 526
Maguey 223, 233, 242
Mahala mats............................... 100
Page.
Mahogany 98
  mountain 98
Majorana 230
Malapoenna geniculata 453
Mallow, low................................ 414
Malpighaceae 217
Malus 458
  angustifolia 485, 492, 528
Malva angustifolia 177
  hederacea 176
  parviflora 180
  rotundifolia 414, 533
Malvaceae 146, 230, 235, 250, 253, 317, 462, 533
  notes 170-181
Malvastrum greenmanianum 180
  pedatifidum............................. 177
  schaffneri 180
  tricuspidatum............................ 181
Malvaviscus lanceolata 175
  palmeri 175
  pringlei 175
Mamillaria................................. 258
  senilis 258
Mamillopsis................................ 258
Manfreda and related genera, key 153
  spp 145, 233
Manfredas 152, 153, 155, 242, 246
Mango 214
Manisuris rugosa.......................... 451
Manzanilla................................. 230
Manzanita 102
Maple 418, 483
  mountain 59
  red 334, 398, 404, 418
      421, 422, 426, 429, 431, 436, 476, 478, 479, 480, 482
  sugar.................................... 482
Maquis..................................... 272
Marah...................................... 115
  minima................................... 117
Margarita................................... 229
Maritime formations....................... 485
  plant formations 360-395
Marram grass 333, 368, 369
Marrubio 230
Marrubium vulgare 230
Marsh grass................................. 91
Marshallia graminifolia................... 457
Mats 92, 99, 237, 239, 241
Mayaca aubleti 452
Maypop 471
Maytenus phyllanthoides.................. 109
Meadow fescue 412, 469
  grasses 480
Medicago lupulina.................... 412, 520
Medicinal plants of Mexico........... 227-231
Megarrhiza 115
Megarrhiza................................. 115
Meibomia 380, 386, 402, 405, 406, 468, 530
  arenicola...................... 385, 454, 530
  dillenii 530
  marylandica 530
  nudiflora 530
  obtusa.................................... 530
  paniculata 316
    chapmani 530
    pubens 530

Page.
Meibomia rigida 530
    stricta 382, 405, 454, 530
    tenuifolia 454
    viridiflora 530
Melastomaceae 443, 462, 534
Melia azedarach 413, 531
Meliaceae 189, 229, 531
Melica acuminata 38
    mutica 516
    spectabilis 35
Melon zapote 214
Melons 346
Melothria donnell-smithii 122
    pendula 272, 318, 416, 456, 542
    pendula 120
    scabra 122, 181
Mentha canadensis 104
    rotundifolia 414, 539
    spicata 539
Mentzelia albicaulis 100
Menziesia 60
Mescal 224, 230
    flasks 259
    maguey 224
    plant 210
Mesembryanthemum 392
Mesosphaerum rugosum 456, 539
    suaveolens 225
Metate 210, 225
Mexican almonds 221
    and Central American plants 145-200
    beverage plants 223
    brush and broom plants 252
    dye plants 237, 238
    fence and hedge plants 253-255
    fiber plants 239-253
    fruits 214-223
    medicinal plants 227-231
    plants, new or rare species 195-200
    plum 210, 217, 218
    seasoning and flavoring plants 226
    soap plants 231-237
    tanning plants 237, 238
    wild flowers 256
    wood-yielding plants 255, 256
Mexico, cereals and vegetables 210-213
    notes on useful plants 209-256
    studies of plants 145-200
Micrampelis 115
Micranthemum micranthemoides 456
    orbiculatum 456
Microsechium helleri 122
Midshipman's butter 215
Mikania 458
    scandens 274, 318
    scandens 384, 416
Millet, German 412, 489
Milling and logging in Cœur d'Alenes 39
Mimosa acanthocarpa 141
    caerulea 141
    lacerata 141
    xanti 141
Mimosaceae 529
Mimulus 458
    ringens 540
Mineral deposits of Cœur d'Alenes 22-25

Page.
Minerals of Cœur d'Alenes 24,25
Mines of Cœur d'Alenes 23,24
Mining in Cœur d'Alenes 2
Minkelersia 142
    biflora 142,143
    galactioides 142
    multiflora 142
    pauciflora 142
Mint 104, 224, 414
    round-leaved 414
Mistletoe 421, 423
Mitchella 458
    repens 402, 405, 421, 435, 541
Mitreola petiolata 274, 317
Mixed forest 485
Mnium affine 511
Mockernut hickory 407
Mollugo verticillata . 276, 316, 370, 376, 385, 388, 525
Momordica charantia 123
    charantia abbreviata 122
    operculata 123
    zeylanica 122
Monarda 458
    punctata 318, 377, 392, 393, 402, 408, 539
Monimiaceae 508
Monkey's dinner bell 257
Monniera acuminata 405, 456, 540
    caroliniana 456
    monniera 274, 276, 279, 305, 310, 311, 312, 313, 318, 363, 366, 456, 459, 485, 540
Monocotyledones 513
Monotropa uniflora 402, 460, 536
Monotropaceae 462, 536
Monotypic genera 458, 459
Moquilea kunthiana 196
Moraceae 316, 462, 534
Morning-glory 414, 472
Morus 458
    rubra 399, 534
Moss, black 87
    peat 381, 417, 428, 471
    Spanish 271, 382, 421, 471
    yellow 88
Mosses 59, 76, 272, 314, 402, 408, 421, 498
    in mixed forest 402, 408
Mountain ash 55, 60
    grass 256
    maple 55, 59
Muhlenbergia 252, 282, 286
    capillaris 287, 288, 515
    filipes 270, 278, 282, 285, 286, 287, 288, 299, 300, 318, 315, 451
    trichopodes 287, 288
Mulberry 275
    paper 413
    red 399
Muscadine grape 375, 407, 420, 470, 471, 477, 479
Musci 314, 510
Muskmelons 347
Mustard 224
Myginda scoparia 109
Myrica 280, 373, 377, 378, 393, 394, 408
    association 370-377
    carolinensis 271, 272, 294, 299, 300, 316, 370, 371, 372, 377, 379, 382, 386, 390, 392, 400, 404, 477, 479, 485, 523, 540, 545

Page.
Myrica cerifera 271, 294, 299, 300, 316, 335, 453, 485, 523
Myricaceae 316, 462, 523
Myriophyllum 444
  pinnatum 455
  heterophyllum 444, 446, 535
Myrtaceae 221, 374, 506
Myrtle 372, 473, 477, 479, 523
  crape 413
  wax 335, 400
Myrtus arayan 221, 225

N.

Nabalus 458
  albus 543
  virgatus 456
Naiadaceae 462, 513
Nama quadrivalvis 456
Nanche 217, 227
Nansemond escarpment 395
Nelumbo 446, 447, 458
  lutea 444, 446, 526
Neowashingtonia sonorae 255
Nepetaceae 104, 318, 461, 462, 539
Nephrodium molle 147
Nesaea longipes 199
  pringlei 198, 199
Nettle 95
  fiber, uses 95
  horse 414, 473
Neurocarpum javitense 169
Nicotiana attenuata 104
  rustica 258
Nissolia 146, 157
  confertiflora 157, 160
    laxior 157, 162
  diversifolia 160
  dodgei 161, 163
  fruticosa 157, 162, 163
  guatemalensis 162
  hirsuta 157, 160
  hirsutiflora 163
  laxior 162
  multiflora 161
  nelsoni 162
  North American species, synopsis 157-163
  platycalyx 157, 159
  platycarpa 157, 163
  pringlei 158
  racemosa 157, 163
  schottii 157, 158, 160, 163
  setosa 157
  wislizeni 157, 158, 160, 163
Nitidae 135
Nolina 240
Nonhygrophile inland formations 360, 395-416
Nonpalustrine species 450
Notholaena ferruginea 148
  nivea 148
    dealbata 148
  schaffneri mexicana 148
  sinuata 149
Nothoscordum bivalve 402, 521
  striatum 402
Nuphar 458
Nut grass
Nymphaea 458
  advena 444, 446, 526
  polysepala 96
  sagittaefolia 453
Nymphaeaceae 96, 446, 462, 526
Nyssa 314, 419, 458
  aquatica 426, 434, 449, 455, 536
  biflora 334, 417, 418, 419, 420, 421, 426, 434, 449, 455, 479, 480, 524, 532, 536
  sylvatica 379, 399, 404, 476, 477, 536
  uniflora 418, 431, 479, 482, 485, 498

O.

Oak 238, 250, 271, 314, 334, 338, 382, 398, 399, 403, 404, 405, 407, 426, 473, 477, 478, 483, 484
  barren 483
  black 482
  black-jack 482
  chestnut 483
  cow 398, 400, 479
  laurel 379, 398, 400
  live 271, 276, 372, 378, 387, 389, 412, 483
  overcup 482, 483
  post 398, 399, 400, 402, 482
  quercitron 477
  red 398, 400, 407, 478, 482, 483
  rocky 482
  scroby 482
  scrub 484
  Spanish 373, 398, 400, 477, 478
  water 398, 400, 407, 476, 477, 483, 524
  white 398, 400, 407, 476, 477, 478, 482, 483
  willow 398, 400, 407, 476, 477, 478, 479, 483
Oats 411, 468, 469, 480
  sea 368, 369
Ocracoke Island, bibliography 319
    climate 262-266
    cultivated plants 275
    geology 267
    humidity 264
    list of plants 315-318
    physiography 266
    rainfall 265
    soils 267
    sunshine records 264
    temperature records 262
    wind records 266
Odontoschisma sphagni 510
Oenothera 281, 394, 458
  hookeri 100
  humifusa 271, 276, 279, 281, 297, 299, 300, 313, 347, 370, 376, 382, 385, 386, 388, 389, 393, 394, 455, 485, 535
  laciniata 460, 535
Oleaceae 462, 537
Oldenlandia glomerata 318
  uniflora 318, 456, 460, 541
Olea americana 483
Olive 217, 226, 227
  American 483
  oil 230, 232
Olla 224
On[illegible]a biennis 535
[illegible]aceae 100, 317, 443, 462, 534

Page.
Onion, wild ... 414
Onions ... 37, 226, 465
Onoclea sensibilis ... 512
Open formations ... 269, 270
  or light, swamp ... 423–429
  marsh ... 485
Oplismenus setarius ... 272, 315, 451
Opulaster ... 58
Opuntia ... 220, 280, 458
  ficus-indica ... 220
  opuntia ... 380, 382, 391, 393, 402, 455, 534
  pes-corvi ... 270, 279, 280, 313, 317, 455
  spp ... 254
  tuna ... 220
  vulgaris ... 402, 405
Orange ... 214
Orchard grass ... 412, 460
Orchidaceae ... 145, 461, 462, 522
Orchids ... 435, 438
Oregano ... 225, 227, 254
Oregon fir ... 43
  grape ... 96, 97
Orobanchaceae ... 462, 541
Orobanche minor ... 413, 473, 541
Orontium aquaticum ... 452
Oryzopsis exigua ... 36
Osage orange ... 413
Osmanthus americanus ... 455
Osmunda ... 402, 458
  cinnamomea ... 423, 511
  regalis ... 423, 440, 460, 511
Osmundaceae ... 462, 511
Ostrya ... 458
  virginiana ... 400, 523
Overcup oak ... 482, 483
Oxalidaceae ... 462, 531
Oxalis cymosa ... 531
  filipes ... 531
  recurva ... 531
  sp ... 145
  stricta ... 531
  violacea ... 531
Ox-eye, sea ... 364
Oxydendrum ... 404, 405, 458, 477, 478
  arboreum ... 398, 400, 404, 476, 479, 536
Oxycoccus ... 458
  macrocarpus ... 378, 471, 485, 503, 537

P.

Pachystima myrsinites ... 32, 59
Palisade tissue ... 433
Palm ... 239, 257, 438
  date ... 214
  leaves ... 252, 253
    uses ... 239, 240
  nut ... 214, 232
  oil ... 230, 232
  tree products ... 259
Palma loca ... 241, 243, 245
Palmaceae ... 214, 232, 239
Palmetto ... 483
  cabbage ... 484
Palo blanco ... 238
Palustrine forest ... 334
    of Coastal Plain ... 338
  plants ... 485
  species ... 450

Page.
Pamita ... 225
Paniceae ... 461
Panicularia brachyphylla ... 435, 450, 517
  fluitans ... 91
  obtusa ... 450, 517
  pallida ... 435, 439, 440, 450, 517
Panicum ... 382, 388, 404, 405, 515
  agrostoides ... 378, 514
  amarum ... 279, 281, 282, 285, 299, 300, 333, 375, 376, 382, 383, 384, 388, 389, 390, 392, 394, 451, 485, 514
    minus ... 271, 276, 285, 313, 315, 368, 370, 375, 379, 382, 451, 514
  angustifolium ... 377, 451, 514
  barbulatum ... 514
  ciliatum ... 381, 451, 514
  colonum ... 514
  columbianum ... 451
  commonsianum ... 514
  commutatum ... 514
  crus galli ... 409, 414, 472, 514
  dichotomum ... 514
  digitarioides ... 451
  gibbum ... 435, 439, 440, 449, 451, 460, 514
  hians ... 451
  lanuginosum ... 315, 451
  latifolium ... 514
  laxiflorum ... 272, 315, 404, 514
  longifolium ... 451, 514
  microcarpon ... 514
  nashianum ... 451
  neuranthum ... 270, 315, 451, 514
  pauciflorum ... 451, 514
  proliferum ... 409, 414, 472
  pubescens ... 514, 515
  rostratum ... 402, 514
  sanguinale ... 411
  scabriusculum ... 440, 451, 514
  scribnerianum ... 377
  sphaerocarpon ... 514
  sphagnicola ... 378, 451, 515
  verrucosum ... 402, 439, 451, 515
  virgatum ... 363, 364, 375, 378, 382, 515
  viscidum ... 439, 451, 515
  walteri ... 374, 315
Papa ... 227
Papaveraceae ... 408, 527
Papaw ... 471, 488
  gum ... 419, 535
Papaya ... 214
Paper mulberry ... 413
  stock ... 48, 55
Parasites ... 436
Parietaria debilis ... 272, 313, 316, 453
Parsnip, cow ... 101
Parthenium ... 458
  integrifolium ... 546
Parthenocissus ... 458
  quinquefolia ... 375, 379, 401, 404, 416, 460, 533
Partridge pea ... 498
Paspalum angustifolium ... 512
  ciliatifolium ... 315
  compressum ... 451, 469
  dasyphyllum ... 512
  distichum ... 273, 274, 276, 315, 368, 460, 512
  floridanum ... 451, 512

Page.
Paspalum floridanum glabratum 513
  laeve 315, 514
  longipedunculatum 514
  membranaceum 451
  paspaloides 451, 514
  praecox 451
  purpurascens 451, 514
Passiflora bryonoides 182
  colimensis 181
  foetida arida 182
  incarnata 455, 471, 534
  laurifolia 142
  lutea 534
  mexicana 182
  nelsoni 142
  notes 182, 183
  serratifolia 182
  sicyoides 182
  suberosa 183
Passifloraceae 462, 534
Pastures 275
Patol 213
Paucijugae 135
Pavia lutea 482
Pea, field 468
  partridge 468
Peach 214, 275, 412, 470
Peaks of Cœur d'Alenes 8
Peanuts in Dismal Swamp region .. 412, 468, 470
Pear, alligator 215
  avocado 215
Pears 30, 214, 412
  Kieffer 470
Peas 346, 347, 411, 465, 466, 468, 469
Peat, character and uses 350
  deposits, Dismal Swamp region. 342, 350, 351
  juniper 424
  moss 381, 417, 428, 471
  red-brown 423
Pedaliaceae 236
Pellaea angustifolia 149
  angustifolia cuneata 149
  atropurpurea 512
  cordata 149
  marginata 149
  marginata pyramidalis 149
  seemanni 149
  ternifolia 149
Peltandra 458
  sagittaefolia 452
  virginica 442, 520
Pentagonia laciniata 506
Pentstemon 458
  hirsutus 540
  pentstemon 540
Pepita 257
Pepper bush 476, 477
  grass 414
  red 210, 212, 226
Pequin 211
Perennial rye grass 412
Perijil 226
Periptera 173
  macrostelis 174
  periptera 173
  punicea 173

Page.
Perrottetia glabrata 110
  longistylis 110
  ovata 110
  quindiuensis 110
Persea borbonia 449, 453
  gratissima 215, 257
  pubescens 382, 399, 404, 419, 425, 431, 433, 449, 453, 477, 479, 485, 489, 526
Persimmon 373, 378, 399, 407, 471, 472, 477, 478, 479, 482
Pes-caprae form of vegetation 276
  formation 368
Peucedanum canbyi 103
Phalaris arundinacea 36
  caroliniana 451
Phanerogams 421, 425
  herbaceous 403
Phaseolus 142
  helvolus 377, 382, 385
  unatus 212
  sp 143
  spp 212
Phegopteris rudis 150
Philadelphus billardieri 491
  lewisii 58, 97
Philotria 458
  canadensis 444, 445, 446, 513
Phleum alpinum 85
  pratense 412, 469, 515
Phoradendron 430, 431, 458
  flavescens 421, 422, 430, 485, 524
Phragmites 365, 367
  communis 363, 516
  phragmites 91
Phryma 458
  leptostachya 460, 541
Phrymaceae 462, 541
Phyllanthus carolinensis 460, 531
Physalis 281
  angulata 456, 459, 539
  sp 210, 212
  virginiana 539
  viscosa 270, 272, 276, 279, 281, 298, 299, 300, 313, 318, 377, 382, 384, 389, 394, 449, 456, 460, 485, 540
Physic nuts 229
Physiognomy of swamp region 358
Physiography of Dismal Swamp region. 331–342
    Ocracoke Island 266
Physostegia denticulata 456, 539
Phytogeographical affinities of the flora 447–462
Phytolacca decandra 316, 377, 525
  icosandra 236
  octandra 236
Phytolaccaceae 234, 316, 462, 525
Picea 47
  engelmanni 43, 47
Pieris 426, 458
  floribunda 500
  japonica 500
  mariana 455, 526
  nitida 426, 432, 449, 455, 460, 495, 500, 526
Pignut 399
Pigweed 414
Piles 53

Page.
Pilocarpus longipes 112
  seloanus 112
Pinaceae 88, 314, 512
Pine 43, 65, 314, 334, 338, 368, 379, 381, 382, 386, 397, 398, 400, 402, 404, 405, 406, 408, 416, 419, 435, 472, 473, 477, 479, 482, 483, 484, 516, 519, 521, 523, 524, 527, 528, 529, 530, 532, 533, 534, 536, 538, 539, 540, 541, 542, 543, 544, 545, 546
  black 43, 46, 48, 58, 59, 60, 68, 70, 87, 89
  bull 43
  dwarf spruce 484
  forest, renewal 397
  highland 484
  loblolly 373, 380, 482
  lodge-pole 87, 89, 104
  long-leaf 406, 482, 483, 484
  rosemary 483, 512
  savanna 483
  short-leaf 338, 417, 425, 476, 477, 478, 483, 512
  spruce 483, 484
  sugar 88
  tamarack 89
  trees, dead, in sand dunes 334
  upland 537
  white 32, 33, 36, 43, 45, 55, 56, 59, 60, 61, 62, 64, 65, 66, 67, 68, 69, 70, 73, 74, 77
  white-barked 43, 46, 54, 56, 60
  woods of sand strand 380
  yellow 31, 32, 36, 43, 44, 45, 46, 48, 49, 50, 55, 56, 58, 59, 61, 62, 67, 68, 69, 70, 72, 73, 75, 88, 89, 106, 399, 402, 483
Pineapple 214
Pinguicula elatior 456
  lutea 456
Pinguiculaceae 541
Pinus 257
  albicaulis 43, 46, 54, 56
  australis 398
  contorta 46
  echinata 381, 382, 398, 399, 483, 512, 520, 528
  lambertiana 88
  mitis 398
  monticola 32, 43, 45, 56
  murrayana 43, 46, 87, 89, 104
  palustris 314, 398, 406, 449, 451, 482
  ponderosa 31, 43, 56, 58, 89
  serotina 483
  taeda 314, 338, 373, 378, 380, 381, 384, 386, 398, 403, 404, 405, 417, 419, 425, 430, 451, 476, 477, 478, 482, 483, 510, 512, 520, 530
Piper palmeri 234, 236
Piperaceae 234
Pipestems 90
Piqueria trinervia 231
Piriqueta 165
  cistoides 165, 167
Pitahaya 220, 221
  acre 221
  dulce 221
Pitaya 220
Pithecoctenium sp 231
Pithecolobium acatlense 195
  dulce 216, 217
  ligusticifolium 217
Pittiera 123
  grandiflora 123

Page.
Pittiera longipedunculata 123
  parvifolia 123
  trilobata 123
Plagiothecium latebricola 511
  micans 510, 511
Plant covering of Ocracoke Island 261-319
  formations of Ocracoke Island 269-275
  growth, relation to soil 473-484
  names for Mexican towns 257
    Klamath Indian 105
  worship in Mexico 257, 258
Plantaginaceae 402, 541
Plantago lanceolata 414, 541
  rugelii 414, 541
  virginica 541
Plantains 414
Plants, anatomy 280-312
  cultivated 275
  introduced, in sand strand 395
  list, Dismal Swamp region 509-547
  pasture 275
  ruderal 275
  sacred, of Mexico 258
  used by Klamath Indians 87
  with subterranean storage 387
Platanaceae 402, 527
Platanus 372
  occidentalis 335, 372, 383, 413, 429, 482, 527
Pleea tenuifolia 453
Pluchea bifrons 318
  camphorata 274, 318, 364, 457, 460, 546
  foetida 318, 457, 485, 508, 546
Plum 30, 31
  Chicasaw 380, 407, 471
  Mexican 210, 217, 218
  wild red 99
Plumbaginaceae 317
Poa 36, 58
  annua 516
  autumnalis 516
  buckleyana 36
  compressa 517
  pratensis 36, 412, 469, 517
  pulchella 36
  purpurascens 36
  serotina 35
Poaceae 91, 315, 461, 462, 513
Podophyllum peltatum 402, 538
Pogonia divaricata 453
  ophioglossoides 460, 522
Poison camas 93
  dogwood 480
  from water hemlock 101
  ivy 375, 421
  vine 407
Polemoniaceae 103, 230
Poles, telegraph 52
Polianthes 151, 152, 153, 154
  tuberosa 154, 237
Polster form of plants 386
Polycodium stamineum 537
Polygala 314
  brevifolia 454
  cymosa 454
  incarnata 402, 531
  lutea 406, 454, 530

Page.
Polygala mariana 405, 531
  ramosa 454
  verticillata 531
Polygalaceae 462, 531
Polygonaceae 95, 316, 462, 525
Polygonatum 458
  biflorum 521
Polygonum arifolium 416, 423, 525
  aviculare 525
  convolvulus 525
  douglasii 95
  hydropiperoides 361, 437, 525
  pennsylvanicum 414, 525
  persicaria 525
  punctatum 316, 525
  punctatum robustior 525
  sagittatum 416, 525
  setaceum 453, 525
  virginianum 525
Polymnia uvedalia 546
Polypetalae 109
Polypodiaceae 314, 462, 512
Polypodium 422
  angustifolium 150
  areolatum 150
  aureum 150
  elasticum 150
  fragile 148
  furfuraceum 150
  incanum 403, 421
  lanceolatum 150, 228
  molle 147
  parasiticum 147
  pectinatum 150
  polypodioides 402, 421, 460, 512
  skinneri 150
  stelliformis 145
  subpetiolatum 150
  thysanolepis 150
  trilobatum 150
Polypremum 458
  procumbens 317, 455, 460, 537
Polystichum acrostichoides 402, 512
Polytrichum commune 381, 511
  ohiense 511
Pontederia 361, 458
  cordata 436, 442, 520
Pontederiaceae 462, 520
Poplar, balm of gilead 94
  silver 413
  yellow 473, 483
Populus 458
  alba 413, 523
  angustifolia 55
  balsamifera 94
  heterophylla 419, 480, 523
  tremuloides 55, 94
Possum-pocket apples 526
Post oak 398, 399, 400, 402, 482
Posts, fence 52, 55
Potamogeton lonchites 445, 446, 513
Potato 29, 31, 90, 226, 227, 275, 346, 347, 354, 357, 410, 411, 464, 465, 466, 467, 468, 469, 479, 480, 481
  wild 227, 530

Page.
Potatoes, early rose 466
  sweet 227, 346, 347, 411, 465, 466
Potentilla 458
  canadensis 528
  monspeliensis 460, 528
  palustris 30
  pumila 450, 528
Prenanthes alba 402
Primrose, evening 100
Primulaceae 317, 462, 537
Pristimera tenella 110
Prochnyanthes 151, 152, 153, 155
  viridescens 155, 234, 237
Proserpinaca 458
  palustris 460, 535
  pectinata 437, 455, 535
Prosopis 257
Prunella vulgaris 539
Prunus 372, 407
  americana 528
  angustifolia 371, 380, 393, 394, 407, 454, 471, 528
  caroliniana 454
  cerasus 529
  chicasa 372
  demissa 55, 98
  emarginata 55-98
  serotina 371, 373, 378, 394, 399, 407, 429, 477, 529
  serotina smallii 529
  subcordata 99
Pseudobravoa 153, 155
  densiflora 155
Pseudo-echinopepon 115
Pseudo-echinopepon 115, 119
Pseudosmodingium multifolium 143
Pseudotsuga 58
  taxifolia 31, 43, 50
Psidium guava 221
  spp 221
Psilocarya nitens 452
Psoralea pedunculata 405, 454, 529
Psorospermum 496
Ptelea trifoliata mollis 165
Pteridophyta 458, 461, 511
Pteridophytes 459
Pteris aquilina 402, 460, 512
    lanuginosa 150
  aurantiaca 148
  cordata 149
  lutea 148
  rigida 149
  ternifolia 149
Pterocarpus acapulcensis 143
  drago 143
Pterocaulon pcynostachyum 457
'tilimnium 458, 535
  capillaceum 440, 455, 535
Pulque 223, 224
  agaves 255
  maguey 224, 245
  plant 210, 223
Pumpkins 466
Puro cecillia 256
Pycnanthemum 458
Pyraceae 462, 528
Pyrolaceae 462, 536
Pyrrhopappus 408, 458

Page.
Pyrus 426
angustifolia 404
angustifolia 492
Pyxidanthera barbulata 455

Q.

Quahtlatlatzin 257
Quaking asp 94
Quamasia leichtlinii 93
quamash 93
Quercitron 398, 400, 407, 477, 478
Quercus 145, 277, 281, 393, 458
alba 398, 404, 405, 407, 476, 478, 523
minor 524
catesbaei 453, 483
cinerea 453, 483
digitata 373, 382, 398, 404, 405, 453, 477, 478, 523
heterophylla 523
ilex 294
imbricaria 482, 523
laurifolia 295, 379, 398, 405, 449, 453, 485, 524
macrocarpa 482
marylandica 524
michauxii 398, 404, 426, 453, 479, 483, 524
minor 381, 398, 399, 404, 405, 520, 524
prinus montana 482
nigra 398, 404, 405, 407, 426, 453, 476, 478, 482, 524
phellos 398, 401, 407, 419, 453, 460, 479, 524
rubra 398, 407, 478, 482, 524
tinctoria 482
virens 294
virens 271, 316, 372, 382
velutina 404, 405, 407, 477, 478, 524
virginiana 271, 272, 276, 279, 281, 294, 295, 299, 300, 313, 316, 372, 379, 382, 383, 386, 388, 389, 390, 398, 449, 453, 460, 485, 524
maritima 370

R.

Rabbit brush 106
Radiant form of plants 385
Radish, wild 413
Radishes 411, 464
Rag weed 413, 414, 472
Railroad cross-ties 55, 63, 66
Rails, fence 46, 52, 55
Rain coats 240
Rainfall of Cœur d'Alenes 2, 13, 14
Dismal Swamp region 328, 329, 357
Ocracoke Island 264
Raisins 226, 227
Raiz 252
Ramalina montagnei 272, 314
Randia sp 256
Ranunculaceae 462, 526
Ranunculus alismaefolius 199
bulbosus 414, 526, 541
madrensis 199
oblongifolius 443
parviflorus 526
pusillus 453
recurvatus 526
sceleratus 526
vagans 199

Page.
Rape, broom 413, 47
Raphanus raphanistrum 413, 52
Raphidostegium microcarpum 51
Raspberry 30, 38, 99, 47
Rattan 420, 479, 53
Red cedar 43, 55, 88, 399, 407, 477, 48
clover 412, 413, 469, 47
fir 31, 43, 4
maple 334, 398, 404, 41
421, 422, 426, 429, 431, 436, 476, 478, 479, 480, 48
mulberry 39
oak 398, 400, 407, 478, 482, 48
peppers 210, 212, 22
Redbud 39
Redtop 46
Reed 91, 335, 422, 472, 468, 51
marsh formation 43
Reel 25
Resin 44, 45, 4
Retranca 244, 24
Rhamnaceae 100, 229, 235, 462, 494, 53
Rhamnus 49
purshiana 55, 10
Rhexia 314, 435, 458, 53
aristosa 45
ciliosa 406, 455, 53
glabella 406, 443, 455, 53
lutea 45
mariana 378, 405, 435, 440, 455, 53
virginica 435, 440, 443, 53
Rhododendroideae 50
Rhus 40
copallina 37
382, 400, 404, 405, 407, 476, 477, 478, 479, 52
glabra 53
radicans 271
316, 375, 382, 401, 404, 407, 416, 421, 53
toxicodendron 53
venenata 49
vernix 426, 480, 53
Rhynchosia erecta 45
simplicifolia 45
tomentosa 406, 416, 454, 53
Ribes aureum 9
cereum 92, 9
oxyacanthoides saxosum 9
Riccia fluitans 445, 51
Rice 217, 41
roots 23
upland 411, 46
wild 43
Ricinus communis 235, 23
Rivers of Cœur d'Alenes 9, 10-1
Dismal Swamp region 33
Robinia pseudacacia 380, 52
Robinsonella cordata 181
discolor 181
divergens 181
lindeniana 181
Rocky Mountain flax 98, 9
oak 48
Root diggers 9
Rootstocks, subterranean 42
Ropes 241, 242, 249, 250
Rosa 58, 45
carolina 408, 426, 431, 436, 485, 491, 5

Page.
Rosa fendleri 99
  humilis 528
  rubiginosa 528
Rosaceae 97, 216, 235, 316, 461, 462, 527
Rosapara 258
Rose, wild 99
Roseanthus albiflorus 124
Rosemary pine 483, 512
Rosette form of plants 386
Rotala ramosior 460, 534
Round-leaved greenbrier 479
  mint 414
Rubia 506
Rubiaceae 318, 461, 462, 505, 506, 541
Rubus argutus 527
    floridus 527
  canadensis 375, 385, 394, 528
  cuneifolius 370, 380, 388, 389, 394, 408, 454, 471, 528
  frondosus 527
  hispidus 401, 405, 528
  leucodermis 38, 99
  nigrobaccus 471, 528, 538
  sp 393, 407
  strigosus 38
  trivialis 270, 276, 280, 316, 382, 385, 408, 454, 528
  ursinus 38
  villosus 375, 385, 394, 404, 471, 528
  vitifolius 38, 99
Rudbeckia 458
  laciniata 546
Ruderal plants 414
Ruellia ciliosa 405, 541
Rumex 274
  acetosella 395, 413, 472, 525
  conglomeratus 414, 525
  crispus 413, 525
  geyeri 95
  obtusifolius 413, 525
  salicifolius 95
  sp 316
  verticillatus 364, 525
Rush 92, 273, 378, 437, 442
Rushes, scouring 88
Rutaceae 110, 217, 316, 462, 531
  notes 163-165
Rutabagas 469
Rye 35, 411, 468, 469
  grass 91
    perennial 412
Rynchospora 405, 442, 437, 461
  axillaris 440, 452, 518
  axillaris microcephala 518
  ciliata 452
  corniculata 406, 439, 452, 519
    macrostachya 452
  cymosa 378, 439, 452, 460, 519
  fascicularis 452, 519
  filifolia 452
  glomerata 437, 439, 440, 519
    paniculata 519
  gracilenta 452
  grayi 452
  inexpansa 405, 437, 439, 452, 519
  knieskernii 452
  megalocarpa 452

Page.
Rynchospora microcephala 452
  miliacea 452
  oligantha 452
  pallida 452
  plumosa 452
  rariflora 452
  schoenoides 452, 519
  spp 406
  torreyana 452
Rynchospora-Eleocharis association 394
Rynchostegium serrulatum 272, 314

S.

Sabal 240, 252, 257
  minor 452
  palmetto 452
Sabbatia 458
  angustifolia 455, 538
  brachiata 455
  calycina 455, 460, 538
  campanulata 455
  dodecandra 437, 455, 538
  elliottii 455
  gracilis 366
  lanceolata 455, 538
  paniculata 455
  stellaris 363, 538
Sablier 257
Sacks 242
Saddle sweaters 239
Sagebrush 98, 105
Sagina 458
  decumbens 414, 526
    smithii 526
Sagittaria 436
  arifolia 90
  graminea 513
  lancifolia 361, 436, 451, 460, 513
  latifolia 90
  subulata 451
  teres 451
Salicaceae 94, 462, 523
Salicornia herbacea 272, 273, 279, 280, 313, 316, 362, 365, 366, 460
Salix 94, 372
  fluviatilis 372, 450, 523
  humilis 523
  lasiandra 55
  longifolia 372, 450
  nigra 419, 436, 523
  sp 255
  wardi 436
Salsola kali 270, 313, 316, 368, 370, 382, 388, 394, 460, 525
Salt in soil moisture, effect 365, 387-392
Salt-loving plants 361
Salt-marsh plant formations 360, 485
  plants, modifications 364-367
  vegetation 272, 301-312
Salt marshes, Dismal Swamp region 337, 338, 344
Saltwort 368
Salvia hispanica 225
  lyrata 539
  spp 225
  tiliaefolia 225

Page.
Sambucus canadensis 407, 429, 542
  glauca 104
Samolus floribundus 317, 400, 537
Samyda mexicana 199
Sand blackberry 380, 470, 471
  drifting, effect on plants 384
Sand-bar willow 478
Sandbox tree 257
Sand-strand formation 359, 367–395, 485
  grasses 282
  of Lynnhaven Bay 381, 382
  plants, effects of exposure to wind 383–387
  vegetation 285–300
Sangre grado 229, 253, 254
Sanguinaria 458
  canadensis 527
Sanicula canadensis 535
  sp. 272, 317
Santalaceae 462, 524
Saphrophytic fungi 395, 401, 403, 421
Sapindus galeotti 236
  inequalis 236
  marginatus 236
  saponaria 236
  sp 236
Saponaria officinalis 526
Sapota elongata 216
Sapotaceae 222
Sarothra 458
  gentianoides 378, 387, 388, 533
Sarracenia 314, 527
  flava 406, 454, 537
  rubra 454
  variolaris 454
Sassafras 399, 494, 405, 407, 460, 476, 472, 477, 478, 479, 482, 458
  sassafras 378, 379, 380, 400, 407, 472, 527
Saururaceae 462, 522
Saururus 435, 439, 458
  cernuus 423, 437, 440, 522
Savila 228
Saw grass 437
Saxifragaceae 97, 462, 527
Scheuchzeriaceae 104, 314
Schizocarpum 124
  attenuatum 124
  filiforme 124
  guatemalense 124
  liebmannii 124
  palmeri 124
  parviflorum 124
Schwalbea americana 456
Scirpus americanus 274, 315, 361, 363, 366, 378, 384, 518
  cylindricus 452
  cyperinus 442
   eriophorum 437, 438, 439, 440, 518
  divaricatus 439, 452, 518
  erianthus 437
   association 435, 437, 439
  lacustris 437, 442, 460, 518
   occidentalis 30, 92
  pungens 274, 315
Scleria pauciflora 460, 519
  torreyana 452
Page.
Scleria triglomerata
  verticillata
Sclerolepis uniflora
Scraper 244,
Scroby oak
Scrophulariaceae 104, 318, 461, 462,
Scrub oaks
Scuppernong grape
Scutellaria integrifolia
  lateriflora 423, 435,
  pilosa
Sea oats 388,
  rocket
  wrack
Seasoning plants 228,
Seasons in Cœur d'Alenes
Sedge 35, 36, 37, 58, 92, 274, 279, 366, 405, 406, 435,
  broom 397, 406, 468,
Sedges in pine barrens
  of Cœur d'Alenes
Sedum tuberculatum
Seeds of strand plants, dissemination 383,
Selaginella apus
Selaginellaceae
Self-fertilizing plants
Selinum
Semilla de Gicaura
Senecio smallii
  tomentosus 406, 415, 457, 472, 485, 509,
Senecionideae
Senna marilandica
Sericocarpus
  asteroides
  bifoliatus 457,
  linifolius
Serviceberry 38, 55, 97, 400,
Sesamum indicum 236, 235,
Sesuvium maritimum 279, 280, 302, 310, 311, 312, 313, 316,
  pentandrum 274, 302,
  portulacastrum
Setaria ventenatii
Seutera maritima 303,
Sheep sorrel 413,
Shin-leaf
Shingles 45, 52,
Shoe lasts
  pegs
Shortleaf pine 338, 417, 425, 476, 477, 478, 483,
Shrubby plants
Shrubs in forest formation 400, 401,
  of cleared areas
Sicyos 11
Sicyos 11
  angulata
  echinocystoides
  cremocarpa
  helleri
  minimus
Sida
  acuta carpinifolia 176,
  alamosana 17
  anomala 17
  carpinifolia 17
  caudatifolia 17

Page.

- Sida cinerea, 176
  - *cristata*, 172
  - diffusa, 176
  - hederacea, 176
  - holwayi, 176
  - *incana*, 170
  - *malvaviscus*, 173
  - neo-mexicana, 176
  - *periptera*, 173
  - *rubra*, 173
  - salviaefolia, 176
  - spinosa, 176, 414, 460, 533
  - *stellata*, 177
  - tragiaefolia, 177
- Sieglingia seslerioides, 516
- Silene antirrhina, 525
- Silphium, 458
  - asteriscus, 457
  - compositum, 457
  - trifoliatum, 546
- Silver poplar, 413
- Simarubaceae, 531
- Sisal hemp, 239, 243
- Sisymbrium canescens, 225
  - incisum, 96
  - officinale, 527
- Sisyrinchium, 458
  - atlanticum, 522
  - graminoides, 522
- Sitilias, 458
  - caroliniana, 408, 456, 543
- Sium cicutaefolium, 102, 437, 535
- Skunk ipazote, 228
- Slew-grass, 91
- Slippery elm, 482
- Small cane, 476, 477, 479
  - fruits, 30
- Smilaceae, 315, 462, 521
- Smilacina racemosa, 402
- Smilax, 280, 383, 387, 401, 407, 435
  - auriculata, 453
  - bona-nox, 270, 271, 280, 315, 375, 379, 382, 390, 401, 485, 521
  - glauca, 375, 379, 388, 389, 401, 521
  - lanceolata, 453
  - laurifolia, 314, 421, 426, 427, 431, 432, 433, 436, 453, 480, 485, 486, 521
  - rotundifolia, 375, 401, 404, 421, 477, 479, 521
  - spp, 389, 393, 416
  - tamnifolia, 453
  - *tamnoides*, 315
  - walteri, 421, 427, 431, 453, 485, 487, 522
- Smodingium, 143
- Smoke vine, 540
- Smut grass, 415
- Snowfall in Cœur d'Alenes, 13, 14
  - Dismal Swamp region, 328, 329
- Snowshoes, frames of willow, 94
- Soap, amole, 232
  - plants of Mexico, 231, 237
- Soapberry, 232
- Soda water, 223
- Soil, peaty juniper, 480
  - relation to plant growth, 473-484
  - rich black-gum, 480
- Soils, arable, Dismal Swamp region, 476
  - chemical factors, 474
  - Dismal Swamp region, 322, 344, 358, 429, 430, 463-466, 473-484
  - effect of drainage, 474
  - in Cœur d'Alenes, 28, 29
  - of forest areas, 404, 405
    - Ocracoke Island, 267
    - wooded swamps, 352, 353, 354
  - truck, Dismal Swamp region, 346-349
- Solanaceae, 227, 230, 318, 462, 539
- Solanum carolinense, 275, 318, 414, 473, 540
  - nigrum, 270, 318, 377, 395, 540
  - tuberosum, 227
- Solidago, 306, 314, 367, 380
  - bicolor, 544
  - canadensis, 409, 544
    - glabrata, 544
  - elliottii, 457
  - erecta, 306, 544
  - fistulosa, 457, 544
  - juncea, 544
  - missouriensis, 544
  - neglecta, 306, 544
  - nemoralis, 544
  - odora, 402, 544
  - petiolaris, 306, 406, 457, 544
  - pilosa, 406
  - puberula pulverulenta, 457
  - pulverulenta, 406, 544
  - rugosa, 544
  - sempervirens, 273, 274, 280, 305, 306, 310, 311, 312, 313, 318, 364, 366, 510, 544, 485
  - serotina, 544
  - sp, 544
  - stricta, 457
  - *tenuifolia*, 318
  - tortifolia, 457
  - ulmifolia, 544
- Soliman, 257
- Sonchus asper, 543
- Sonneratia acida, 433
- Sonorita, 230
- Sorbus occidentalis, 55, 60
  - sambucifolia, 55, 60
- Sorghum in Dismal Swamp region, 412, 471
- Sorrel, sheep, 413, 472
- Sotol, 224, 240, 241
  - liquor, 224
- Sour gum, 476, 477
- Sourwood, 389, 476, 477, 478, 479
- Soyate, 240, 241
- Spanish cedar, 189-191
  - moss, 271, 382, 421. 471
  - needles, 414
  - oak, 373, 398, 400, 477, 478
- Sparganiaceae, 90
- Sparganium androcladum, 445, 446, 513
  - eurycarpum, 30, 90
- Sparkleberry, 400
- Spartina, 272, 273, 366
  - *juncea*, 271, 273, 315, 376, 382
  - patens, 271, 273, 282, 284, 288, 289, 290, 299, 300, 313, 315, 359, 363, 376, 382, 388, 389, 390, 393, 485, 516

Page.

- **Spartina polystachya** 361, 363, 365
  - **stricta** 272, 273, 276, 279, 282, 283, 284, 289, 290, 299, 300, 301, 310, 311, 312, 313, 315, 362, 485
    - **association** 272, 359, 361
    - **maritima** 290, 361, 365, 516
  - **versicolor** 288
- **Spergularia salina** 302
  - *salina* 316
- **Sphaeralcea angustifolia cuspidata** 177
  - **arida** 177
  - **californica** 177
  - **pedatifida** 177
  - **stellata** 177
- **Sphagnaceae** 510
- **Sphagnum** 381, 406, 428, 429, 445, 518, 522
  - **brevicaule** 510
  - **cuspidatum plumosum** 510
    - **plumosum serrata** 444, 445, 446
  - **cymbifolium** 381
    - **glaucescens** 428, 510
    - **glaucescens squarrulosa** 428, 510
  - **henryanum** 381
  - **henryense** 510
  - **imbricatum brevicaule** 406
    - **cristatum glaucescens** 510
  - **kearneyi** 444, 445, 510
  - **medium glaucescens** 511
  - **recurvum** 381
    - **ambliphyllum pulchricoma** 511
  - **virginianum** 511
- **Spikenard tree** 476, 477, 478, 479
- **Spinach** 346, 347, 411, 464
- **Spindle** 251
- **Spinifex squarrosus** 398
- **Spinner** 249, 250, 251
- **Spiraea** 458
  - **tomentosa** 405, 527
- **Spirodela polyrhiza** 444, 446, 459, 520
- **Spondias lutea** 218, 219, 220, 225
  - **mexicana** 219
  - **purpurea** 219, 220
  - **spp** 217
- **Sponge, vegetable** 251
- **Sporobolus asper** 382, 515
  - **indicus** 275, 315, 415, 515
  - **junceus** 451
  - **virginicus** 451
- **Spruce** 43, 48, 68, 74
  - **Douglas** 43, 58, 59, 60, 63, 66, 98, 74, 75
  - **Engelmann's** 43, 47, 55, 59, 60
  - **hemlock** 43, 50, 55
  - **pine** 483, 484
- **Squash** 226, 411, 465, 466
- **Squirrel-tail grass** 413, 414
- **Staff-tree family** 32
- *Statice limonium carolinianum* 317
- **Stegnosperma halimifolia** 231, 236
- **Stegowaltheria** 183
- **Stenophyllus capillaris** 460, 518
  - **ciliatifolius** 452
  - **stenophyllus** 452
- **Stewartia malacodendron** 454
- **Stillingia sylvatica** 454
- **Stipa** 252
  - **avenacea** 402, 404, 515
  - **viridula** 35

Page

- **Stipulicida setacea** 4
- **Stock break** 2
- **Stolons** 4
- **Storax** 4
- **Story tree** 2
- **Strand, Dismal Swamp region** 345, 3
  - **plants** 4
    - **adaptations to environment** 382-3
    - **dissemination of seed** 393, 3
    - **number of families** 3
    - **number of genera** 3
    - **poverty of species** 3
    - **structural peculiarities** 382-3
  - **vegetation, general aspects** 3
- **Strawberries** 30, 346, 347, 411, 413, 464, 465, 466, 470, 472, 4
- **Strawberry, the Brandywine** 4
  - **the Hoffman** 4
  - **the Thompson** 465, 4
  - **wild** 4
- **Strophostyles helvola** 416, 5
  - **umbellata** 5
- **Structures diminishing transpiration** 385-3
- **Stylosanthes** 4
  - **biflora** 405, 408, 5
  - **riparia** 405, 408, 454, 5
- **Styracaceae** 462, 5
- **Styrax** 4
- **Styrax americana** 4
  - **grandifolia** 400, 449, 455, 485, 504, 5
- **Suadadero** 2
- **Subalpine fir** 43, 49, 56, 59, 60, 68, 69,
  - **pine zone of Cœur d'Alenes**
- **Subsoils of Dismal Swamp region** 349, 353, 3
- **Sugar cane** 294, 4
  - **grass**
  - **maple** 4
  - **pine**
- **Sumac** 407, 472, 476, 477, 478, 4
- **Summer grape** 4
- **Sunflower** 4
- **Sunshine record for Dismal Swamp** 2
  - **records for Ocracoke Island** 2
- **Superstitions respecting plants** 227, 257, 2
- **Swamps of the Dismal Swamp region** 338-3
  - **wooded** 349-3
- **Sweet bay** 399, 425, 479, 480, 4
  - **corn** 4
  - **flag**
  - **gum** 338, 39 399, 400, 404, 407, 41 477, 478, 482, 483, 4
  - **potatoes** 227, 346, 347, 411, 465, 4
  - **syringa**
- **Swietenia humilis** 2
- **Switch grass** 3
- **Sycamore** 335, 478, 4
- **Symplocaceae** 462, 5
- **Symplocos adenophylla** 5
  - **tinctoria** 382, 400, 404, 455, 485, 503, 5
- **Syntherisma filiforme** 5
  - **fimbriatum** 5
  - **sanguinale** 469, 4
  - **serotinum** 4
- **Syringa, sweet**

T.

Page.
Tabaco de macuchi 258
Tabardillo 135, 231
Table utensils 256
Tagetes lucida 231, 256
Tallador 244, 248
Tamarack in Cœur d'Alenes 31, 43, 50, 51, 55, 58, 63, 66, 74, 75
  pine 89
  western 43, 63, 64
Tamarinds 212, 224, 225
Tamarindus indica 225, 257
Tampico fiber 243
  hemp 210, 242, 244
    industry, investigation 210
Tanbark 54, 55, 238
Tannin 53, 54
Tanning plants of Mexico 237
Tapemete 249, 246, 250
Tar 44
Tarweed 106
Taxaceae 89
Taxodium 334, 418, 421, 422, 429, 430, 434, 458
  distichum 314, 383, 417, 418, 420, 433, 436, 451, 479, 481, 510, 512
Taxus brevifolia 43, 54, 89
Tecoma 375
  radicans 374, 375, 379, 380. 382, 393, 394, 401, 404, 407, 416, 477, 541
Tecomate 258
Tecote prieto 238
Tehuino 225
Tejocote 216, 241
Telegraph poles 52, 55, 66
Temperatures in Cœur d'Alenes 19, 20, 21
    the Dismal Swamp region 324, 325
    Ocracoke Island 262, 263
Tepahuaje 229
Tequila 224
  bastard 249
Terminalia catappa 221
Tetereta 257
Tetradymia canescens 106
Tetrapterys nelsoni 143
Teucrium 281
  canadense 297, 559
  nashii 270, 276, 279, 281, 297, 299, 300, 318, 456
Thalictrum 185
  cuernavacanum 186, 187
  grandiflorum 143, 144, 188
  grandifolium 188
  guatemalense 188
  ichangense 186
  jaliscanum 186, 187
  lanatum 189
  madrense 188
  Mexican species, notes 185–189
  pachucense 188
  papillosum 189
  peltatum 185, 186, 187, 188
  pinnatum 188
  pringlei 185, 186, 187, 188
  pubigerum 187
  purpurascens 526
Thallophyta 510, 461
Thatching 256

Page.
Thatchy grass 361
The Plain, Dismal Swamp region 338, 342, 345, 349
Thelia hirtella 511
Thicket formation 272
Thistle 271
  flowering 408
Thorn 55, 59
Thread 242, 249, 250, 251
Thuidium recognitum 511
  scitum 511
Thuja plicata 43, 51
Tidal Flat formation 274
Tillandsia 392, 458
  usneoides 271, 313, 315, 382, 402, 421, 449, 453, 520
Timothy 29, 30, 35, 36, 412, 469, 473, 480
  wild 35
Tipularia 458
  unifolia 421, 435, 522
Tissa marina 274, 279, 280, 283, 302, 310, 311, 312, 313, 316, 460
Tobacco 93, 102, 230, 258, 412, 471, 480
  in Dismal Swamp region 471
  wild 104
  wrapper leaf 471
Tofieldia glabra 453
  racemosa 453
Toloachi 220
Tomale 217, 221, 226, 237
Tomatoes 210, 212, 346, 347, 411, 465, 466
Tontellea hookeriana 110
Topography of Cœur d'Alenes 6–10
Torote 238
Tortilla 210, 211, 226
Toxylon pomiferum 418
Trachelospermum 458
  difforme 406, 456, 460, 538
Tradescantia 204
  brevifolia 207
  gigantea 205
  humilis 204
  leiandra 207, 208
    brevifolia 207
    ovata 207
  new species 204–206
    pilosa 208
  rosea 453
  scopulorum 205
  sp 145
  speciosa 207
  tumida 208
  virginiana 204, 205, 208
    flexuosa 208
    tumida 208
Tragia urens 382, 402, 454, 532
Transition zone 447, 448, 449
Tree cotton 250
  ferns 436
Trees of cleared areas 406, 407
Treleasea 207
  a new genus of Commelinaceae 207, 208
  brevifolia 207
  leiandra 208
  tumida 145, 208
Triadenum 458
  petiolatum 455, 533

Page.
Triadenum virginicum 435, 438, 440, 460, 533
Trianosperma attenuata 121
Trichocolea tomentella 510
Trichostema lineare 456
  dichotomum 539
Trifolium arvense 529
  carolinianum 454
  dubium 408, 529
  hybridum 529
  incarnatum 412
  pratense 412, 529, 541
  procumbens 529
  repens 412, 529
Triglochin maritima 90
  striata 274, 279, 283, 301, 310, 311, 312, 313, 314, 451, 460
Trilisa odoratissima 457
  paniculata 406, 457, 544
Triosteum perfoliatum 506
Triphasia trifoliata 112
Triplasis 458
  americana 451
  purpurea 270, 315, 376, 516
Trisetum canescens 35
  palustre 437
  pennnsylvanicum 516
  subspicatum 36
Trompa 251
Tropical region 447
Truck crops, Dismal Swamp region 411, 463-466
  lands, native vegetation 476-479
  soils, Dismal Swamp region 345-349, 463-466, 476-484
    fertilizing 347
Trucking 354
  about Norfolk 346, 463-466
  Dismal Swamp region 346-349
Trumpet creeper 375, 407, 477
Tsuga mertensiana 43, 53, 54
  pattoniana 43, 53
Tule 30, 92
Tulip 407, 419, 473, 477
  tree, white 482
    yellow 482
Tuna 209, 210, 220
Tuna fruits, importation 210
Tunas, suggested introduction 209
Tupelo 483
Turnips 465
Turnera 230
  alba 166
  aphrodisiaca 166, 167
  caerulea 166, 167
  callosa 165, 167, 168
  cistoides 167
  diffusa 167
    aphrodisiaca 166, 167
  hindsiana 167
  humifusa 166, 167, 168, 230
  mollis 167
  palmeri 165, 167, 168
  panamensis 167
  pringlei 166, 167, 168
  pumilea 167, 168
  sp 167
  trioniflora 167

Page
Turnera ulmifolia 166, 167, 1
    acuta 167, 1
    alba 166, 167, 1
    caerulea 166, 167, 1
    elegans 1
    surinamensis 166, 167, 1
    velutina 166, 1
  velutina 1
Turneraceae 2
  notes 165-1
Twine 2
Twirling sticks 88, 89, 1
Typha 90, 279, 314, 315, 367, 442, 462, 5
  angustifolia 460, 5
  association 359, 3
  latifolia 3
    90, 273, 276, 314 361, 363, 366, 436, 438, 442, 5
Typha-Sagittaria association 4

U.

Ulmaceae 462, 5
Ulmus 4
  alata 453, 5
  americana 399, 5
  viscosa 4
Umbelliferae 145, 2
  a new genus 2
Underdrainage, Dismal Swamp region 3
Uniola 270, 271, 282, 368, 4
  gracilis 272, 315, 3
  latifolia 51
  laxa 272, 315, 380, 451, 51
  longifolia 382, 451, 51
  paniculata 270, 276, 279, 281, 288, 292, 2
    300, 313, 315, 333, 368, 369, 370, 382, 383, 38
    388, 389, 390, 392, 393, 449, 452, 460, 485, 51
Upland rice 411, 4
Upper Austral zone 447, 448, 4
  Sonoran area 4
Urtica breweri 94, 9
Urticaceae 95, 316, 462, 5
Urticastrum divaricatum 5
Useful plants of Mexico, notes 209-2
Usnea angulata 51
  barbata 271, 31
    rubiginea 51
    serotina 51
  spp 40
  trichodea 51
Utricularia 444, 44
  biflora 45
  clandestina 450, 54
  fibrosa 456, 54
  inflata 444, 445, 448, 54
  juncea 45
  purpurea 444, 445, 54
  spp 445, 44
  subulata 45
Uvalama 2
Uvularia 45
  sessilifolia nitida 5

V.

Vacciniaceae 468, 5
Vaccinium arboreum 400, 40
  corymbosum 400, 404, 468, 47

Page.
Vaccinium crassifolium 455
  membranaceum 103
  microphyllum 103
  myrtilloides 38
  myrtillus microphyllus 103
  scoparium 103
  stamineum 401, 479
  vacillans 401, 471, 537
  virgatum 455
    tenellum 401, 455, 477, 479, 537
Vagnera racemosa 521
Valeriana edulis 93, 104
Valerianaceae 104, 450, 462, 542
Valerianella chenopodifolia 450, 542
  radiata leiocarpa 542
Vallisneriaceae 462, 513
Vaseyanthus 115, 119
  brandegei 119
  insularis 120
  rosei 119
  sp 119
Vegetable butter 215
  marrow 215
  tallow 234
Vegetables, garden 30, 31, 38, 210-213, 275, 410, 411, 463
  of Mexico 210-213
Velaea glauca 203
Velvet grass 412
Verbascum blattaria 540
  thapsus 275, 318, 540
Verbena 458
  caroliniana 456
  officinalis 414, 539
  urticifolia 539
Verbenaceae 223, 226, 230, 317, 462, 539
Verbesina occidentalis 546
  pinnatifida 255
  virginica 546
Vernonia noveboracensis 543
  tomentosa 543
  oligophylla 456
Veronica arvensis 540
Vervain 414
Vetches 412, 413, 414, 470
Viburnaceae 104, 542
Viburnum cassinoides 542
  dentatum 429, 542
  molle 456
  nudum 426, 456, 542
  obovatum 456
  prunifolium 542
Vicia angustifolia 412, 414, 530
  hirsuta 414, 530
  sativa 412, 413, 414, 530, 541
Viciaceae 316, 461, 462, 529
Vigna catjang 412
Vinca major 538
Vincetoxicum carolinense 416, 456, 538
  gonocarpos 456
  hirsutum 456
  palustre 273, 279, 280, 303, 310, 311, 312, 313, 317
  suberosum 456
Vinegar 223
Vino tecomate 259

Page.
Violaceae 462, 534
Viola asarifolia 534
  brittoniana 534
  emarginata 534
  lanceolata 440, 534
  pedata 402, 534
  primulaefolia 440, 534
  septemloba 455
  sororia 534
  sp 534
Violets 440
Virginia creeper 375
Vismia 496
Vismieae 496
Vitaceae 317, 463, 533
Vitellaria mammosa 222
Vitex mollis 223
Vitis aestivalis 271, 317, 375, 379, 394, 401, 479, 533
  cordifolia 533
  labrusca 421, 470, 533
  rotundifolia 374, 375, 394, 401, 404, 407, 421, 454, 471, 477, 479, 533
  spp 401, 416

W.

Walama 223
Walnut, black 399, 473, 479
  white 482
Waltheria 146
  acapulcensis 184
  acuminata 183
  americana 184
  bracteosa 183
  brevipes 184
  detonsa 183, 184
  glomerata 185
  hirsuta 183, 184
  indica 183
  operculata 183
  preslii 184
  rhombifolia 185
  rotundifolia 184
  synopsis 183-185
Wappatoo 90
Wart cress 472
Wash rag 249, 250
Washingtonia sonorae 255
Water ash 419
  cinquefoil 30
  hemlock 101
  lily 96, 444
    seeds 96
    yellow 96
  oak 398, 400, 407, 476, 477, 483, 524
  of Dismal Swamp region 355
  supply in Cœur d'Alenes 38, 39
  uses, in Cœur d'Alenes 38-42
Watermelons 347, 411, 465, 470
Wax bean 213
  myrtle 335, 400
Weeds 275, 413
  in Dismal Swamp region 413, 414, 471
Western larch 43, 59
  tamarack 43, 63, 64
Wheat 29, 35, 353, 411, 468, 473, 480
  bread 210

Page.
Whips made from wild cherry 99
Whisk 252
White ash 53, 419, 482
  bay 483
  camas 93
  cedar 340, 350, 417, 423, 480, 483
  daisy 472
  fir 31, 43, 48, 49, 58, 59, 70, 88
  oak 398, 400, 407, 476, 477, 478, 482, 483
  pine 32, 33, 36, 43, 45, 55, 56, 59, 60, 61, 62, 64, 65, 66, 67, 68, 69, 70, 73, 74, 77
    zone, of Cœur d'Alenes 59
  walnut 482
White-barked pine 43, 46, 54, 56, 60
    zone of Cœur d'Alenes 60
Wild cotton 364
  currants 471, 528
  potato 227, 530
  red plum 99
  rice 437
Willow 55, 59, 69, 94, 214, 255, 436
  black 419
  oak 398, 400, 407, 476, 477, 478, 479, 483
  sand-bar 478
Willughbaeya 458
  scandens 364, 416, 460, 544
Wimmeria 129
  concolor 129, 130
  confusa 129, 130
  cyclocarpa 129
  discolor 129
  pallida 130
  persifolia 130
  pubescens 129
Wind, effects on strand vegetation 383-387
  in Dismal Swamp region 390
  of Ocracoke Island 296
Winds in Cœur d'Alenes 64
Winter grass 472
Wintergreen 413
Wire grass 406
Wissadula acuminata 144, 178
  cincta 178
  hirsutiflora 178
  holosericea 178
  paniculata 178
  pringlei 144, 178
  scabra 177, 178
  tricarpellata 179
  trilobata 178
  wissaduloides 179
Woodbine, scarlet 375
Wooded plain, Dismal Swamp region 415
Wooden utensils 256
Woods, useful 255, 256
Woodsia mexicana 150, 151
  mollis 151
Woodwardia 402, 458
  areolata 423, 440, 512
  radicans 151
  sphagnum 423, 428, 435
    association 428
Woodwardia virginica 428, 438, 512, 518, 522
Wood-yielding plants of Mexico 255, 256
Wormseed 414
Wyethia mollis 106

X.

Page.
Xanthium 270, 275, 318, 370, 393, 394, 543
  italicum 370, 543
  strumarium 413, 414, 473, 543
Xanthoxylum clava-herculis 378, 379, 380, 384, 393, 400, 454, 531
Xerophyllum douglasii 82
Xolisma 458
  foliosiflora 426, 432, 455, 485, 501, 536
  ligustrina 404, 501, 536
Xyridaceae 462, 530
Xyris 439, 442, 530
  ambigua 439, 452, 530
  baldwiniana 452
  caroliniana 439, 452, 530
  communis 452
  fimbriata 453
  platylepis 530
  torta 453, 530

Y.

Yard grass 414
Yarrow 105
Yellow jessamine 477, 479
  pine 31, 32, 36, 43, 44, 45, 46, 48, 49, 50, 55, 56, 58, 59, 61, 62, 67, 68, 69, 70, 72, 73, 75, 88, 89, 106, 399, 402, 483
    zone of Cœur d'Alenes 58
  poplar 473, 483
Yerba de coyote 229
    golondrina 229
    torro 231
  del cancer 229
  nil 231
Yew 43, 54, 89
  in Cœur d'Alenes 54, 55
  short-leaved 43
Ystle 245
Yucca 232, 239, 241, 243, 244, 280, 281, 453
  aloifolia 271, 293, 299, 300, 313, 315, 453
  angustifolia 237
  baccata 232, 237
  filamentosa 380, 382, 391, 393, 453, 521
  filifera 241
  gloriosa 271, 293, 299, 300, 313, 315, 453
  leaves 252
  rupicola rigida 237
  spp 279, 280
  treculeana 241
  wood 248

Z.

Zanthoxylum 280
  affine 165
  arborescens 112, 164
  clava-herculis 270, 271, 295, 299, 300, 313, 316, 449, 485
  foetidum 112, 164
  ghisbreghtii 164
  insulare 163, 165
  limoncello 113, 164
  longipipes 163, 164
  melanostrictum 112, 164
  nelsoni 164, 165
  occidentale 164
  pentanome 164

Page.
Zanthoxylum pringlei 165
  pterota 112, 164
  rigidum 165
Zapote amarillo 216
  blanco 217
  chico 222
  prieto 223
Zea mays 210
Zebrina leiandra 207
Zenobia cassinefolia 455
Zephyranthes 458
  sp. nov 145
  atamasco 402, 449
  carinata 237

Page.
Zinnia linearis 231, 256
Zizania 458
  aquatica 361, 437, 460, 515
Zizaniopsis miliacea 451
Zizyphus 232
  mexicana 235, 236
  spina-cristi 494
Zones, forest, of Cœur d'Alenes 56-61
Zornia bracteata 406, 454, 530
Zostera marina 368
Zygadenus glaberrimus 453
  leimanthoides 453
  venenosus 93
Zygophyllaceae 229

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DIVISION OF BOTANY.

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Vol. V.

SYSTEMATIC, ECONOMIC, AND ECOLOGICAL INVESTIGATIONS.

BOTANICAL SURVEY OF THE CŒUR D'ALENE MOUNTAINS, IDAHO; PLANTS USED BY THE KLAMATH INDIANS OF OREGON; DESCRIPTIONS OF MEXICAN, CENTRAL AMERICAN, TEXAN, AND NORTHWESTERN PLANTS; MEXICAN ECONOMIC PLANTS; PLANT COVERING OF OCRACOKE ISLAND, NORTH CAROLINA; BOTANICAL SURVEY OF THE DISMAL SWAMP REGION.

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PREFATORY NOTE.

In the act of Congress making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1889, provision was made for botanical exploration and the collecting of plants in little-known districts of America, in connection with the United States National Herbarium, and in the appropriation for 1891 additional provision was made for the publication of reports. Since those years similar provisions have been made annually. As a partial result of these appropriations, the Department has issued heretofore five completed volumes—I, II, III, IV, and VI—of a series of publications entitled Contributions from the United States National Herbarium. Another volume, V, has now been brought to completion.

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WASHINGTON, D. C., *October, 1901.*

CONTENTS.

Pa

Introduction to the report on the Cœur d'Alene Mountains. By Frederick V. Coville

General report on a botanical survey of the Cœur d'Alene Mountains in Idaho during the summer of 1895. By John B. Leiberg

Notes on the plants used by the Klamath Indians of Oregon. By Frederick V. Coville

Studies of Mexican and Central American plants—No. 1. By J. N. Rose

Studies of Mexican and Central American plants—No. 2. By J. N. Rose

Two new species of plants from the northwestern United States. By L. F. Henderson

Hesperogenia, a new genus of Umbelliferae from Mount Rainier. By J. M. Coulter and J. N. Rose

Three new species of Tradescantia from the United States. By J. N. Rose

Treleasea, a new genus of Commelinaceae. By J. N. Rose

Notes on useful plants of Mexico. By J. N. Rose

The plant covering of Ocracoke Island; a study in the ecology of the North Carolina strand vegetation. By Thomas H. Kearney

Report on a botanical survey of the Dismal Swamp region. By Thomas H. Kearney

ILLUSTRATIONS.

PLATES.

Page.
PLATE I. Map of northern Idaho .... Frontispiece.
II. *Esenbeckia macrantha* Rose 111
III. *Esenbeckia acapulcensis* Rose 111
Esenbeckia berlandieri Baillon 111
IV. *Echinopepon pringlei* Rose 117
V. *Pittiera parvifolia* Rose 123
VI. *Schizocarpum attenuatum* Rose 124
VII. *Heliocarpus americanus* L 125
VIII. *Heliocarpus occidentalis* Rose 127
IX. *Heliocarpus reticulatus* Rose 128
X. *Heliocarpus pallidus* Rose 129
XI. *Abutilon bakerianum* Rose 133
XII. *Abutilon nelsoni* Rose 134
XIII. *Brongniartia suberea* Rose 134
XIV. *Crotalaria filifolia* Rose 136
XV. *Cuphea nelsoni* Rose 137
XVI. *Gymnogramme subcordata* Eaton & Davenport 138
XVII. *Passiflora nelsoni* Rose 142
XVIII. *Pseudobravoa densiflora* (Robinson & Fernald) 155
XIX. *Periptera macrostelis* Rose 174
XX. *Passiflora colimensis* Masters & Rose 181
XXI. *Thalictrum peltatum* DC 186
XXII. *Cuphea trichopetala* Rose 196
XXIII. *Cuphea cristata* Rose 196
XXIV. *Cuphea koehneana* Rose 197
XXV. *Ranunculus madrensis* Rose 199
XXVI. *Angelica roseana* Henderson 201
XXVII. *Hesperogenia stricklandi* Coult. & Rose 203
XXVIII. Fruits and tortilla 212
XXIX. Ciruelas—fruit of *Spondias* spp 219
XXX. Garambullo, *Cereus geometrizans* Mart 220
XXXI. Pulque plant or maguey, *Agave atrovirens* Karw 224
XXXII. Pulque plant or maguey, *Agave atrovirens* Karw 224
XXXIII. Pulque plant or maguey, *Agave atrovirens* Karw 224
XXXIV. Rootstocks of an agave (Manfreda) used for soap 234
XXXV. Guererro Indians bringing palm leaves from the Pacific 240
XXXVI. Hat braids made from sotol and soyate 241
XXXVII. Articles made from sotol and soyate leaves 241
XXXVIII. Isote, *Yucca treculeana* Carr., as seen near the Piramide del Sol, northeast of the City of Mexico 241
XXXIX. Cogollos of plants furnishing Tampico hemp .... [illegible]
XL. Small bunch of Tampico fiber .... [illegible]

Page.
PLATE XLI. Small bunch of Tampico fiber ... 243
XLII. Strings made by hand from Tampico fiber ... 243
XLIII. Strings made by hand from Tampico fiber ... 243
XLIV. Mexicans making bagging out of ixtle fiber ... 243
XLV. Mexicans making bagging out of ixtle fiber ... 243
XLVI. Process of twisting ixtle fiber into twine ... 243
XLVII. Lechuguilla plant with burro ... 248
XLVIII. Instruments used in extracting ixtle fiber ... 248
XLIX. Instruments used in extracting ixtle fiber ... 248
L. Articles made from ixtle fiber ... 250
LI. A fiber twister ... 250
LII. Agave fiber and manufacturing implements ... 250
LIII. Cotton fiber and implements ... 251
LIV. Brushes of palm leaf and grass ... 252
LV. Hairbrushes made from Tampico fiber ... 252
LVI. Brushes made from several kinds of fiber ... 252
LVII. Hairbrush made from a fruit of *Cereus pecten-aboriginum* Engelm ... 253
LVIII. *Cereus pecten-aboriginum* Engelm ... 254
LIX. Organo, *Cereus marginatus* DC., used for fences near the City of Mexico ... 255
LX. Organo, *Cereus marginatus* DC., used for fences near the City of Mexico ... 255
LXI. Wooden articles ... 256
LXII. Sacred cactus, *Mamillaria senilis* Lodd ... 258
LXIII. Vessels made from Crescentia fruits ... 259
LXIV. Gourd used for a water vessel ... 259
LXV. Lake Drummond, Dismal Swamp ... 321
LXVI. View near the headwaters of Northwest River, Dismal Swamp ... 332
LXVII. View in the Black Gum swamp ... 352
LXVIII. Cypress trees in Lake Drummond, bearing Spanish moss (*Tillandsia usneoides*) ... 420
LXIX. Black Gum swamp, showing knees of the cypress (Taxodium) and arched roots of the black gum (*Nyssa biflora*) ... 420
LXX. Poison ivy (*Rhus radicans*) in Black Gum swamp (on the right); cane (*Arundinaria macrosperma*) and *Osmunda regalis* (foreground) ... 422
LXXI. Big cane (*Arundinaria macrosperma*) along a ditch in Black Gum forest ... 422
LXXII. Association of shrubs and small trees along ditches in the "light swamp" ... 436
LXXIII. Cypress knees and black gums (*Nyssa biflora*) with swollen bases ... 434
LXXIV. The Dismal Swamp Canal near South Mills, N. C ... 440
LXXV. Feeder connecting the Dismal Swamp Canal with Lake Drummond ... 440
LXXVI. Horse-tooth corn on land cleared from the Dismal Swamp at Wallaceton, Va ... 464
LXXVII. Timothy meadow on land cleared from the Dismal Swamp at Wallaceton, Va ... 464

TEXT FIGURES.

FIG. 1. *Cassia nelsoni* Rose ... 135
2. *Gouania pallida* Rose ... 188
3. *Gouania stipularis* DC ... 188

Page.
FIG. 4. *Hiraea polybotrya* Juss 139
5. *Mimosa lacerata* Rose 141
6. *Pseudosmodingium multiflorum* Rose 143
7. Flowers of *Polianthes tuberosa* L. 154
8. Flowers of *Polianthes* sp 154
9. Flowers of *Polianthes* sp 154
10. Flowers of *Bravoa geminiflora* Lex 154
11. Flowers of *Prochnyanthes viridescens* Wats 155
12. Flower of *Manfreda virginica* Salisb 155
13. Manfreda seedling 155
14. Manfreda bulb, cross section 155
15. Flower of *Agave americana* L. 156
16. Agave seedling 156
17. *Nissolia wislizeni* Gray 158
18. *Nissolia schottii* (Torr.) Gray 159
19. *Nissolia platycalyx* Wats 159
20. *Nissolia pringlei* Rose 160
21. *Nissolia diversifolia* Rose 160
22. *Nissolia hirsuta* DC 161
23. *Nissolia dodgei* Rose 161
24. *Nissolia multiflora* Rose 161
25. *Nissolia laxior* (Robinson) Rose 162
26. *Nissolia nelsoni* Rose 162
27. *Nissolia fruticosa* Jacq 163
28. *Anoda hastata* Cav 172
29. *Periptera periptera* (Sims) Rose 173
30. *Gronovia longiflora* Rose 198
31. Huamuchil, *Pithecolobium dulce* Benth 216
32 *Cereus pecten-aboriginum* Engelm 254
33. *Muhlenbergia filipes*, transverse section of leaf 286
34. *Muhlenbergia filipes*, ventral epidermis of leaf 286
35. *Muhlenbergia filipes*, dorsal part of leaf blade 286
36. *Muhlenbergia filipes*, portion of mestome bundle 287
37. *Chloris petraea*, leaf blade 290
38. *Chloris petraea*, ventral portion of leaf blade 291
39. *Chloris petraea*, large mestome bundle from leaf blade 291
40. *Chloris petraea*, three small mestome bundles from the blade 292
41. *Yucca aloifolia*, leaf surface 293
42. *Yucca aloifolia*, a stoma 293
43. *Quercus virginiana*, stellate hair from dorsal leaf surface 295
44. *Croton maritimus*, hair from dorsal leaf surface 296
45. *Physalis viscosa*, branched hair from leaf 298
46. *Tissa marina*, glandular hair from leaf margin 302
47. *Lippia nodiflora*, stomata and hairs 304
48. *Iva frutescens*, hair from ventral leaf surface 308
49. *Borrichia frutescens*, leaf section 309
50. *Borrichia frutescens*, leaf hairs 309
51. Inner slope of high dunes at Cape Henry, Va., showing advance on "The Desert" 333
52. Incursion of the sand on inland vegetation near Cape Henry, Va 334
53. Incursion of the sand on inland vegetation near Cape Henry, Va 335
54. "The Desert" from the high dunes at Cape Henry, Va 336
55. Terrace along the shore near Virginia Beach; sand above, clay below 337

Page.
FIG. 56. Cypress stumps on the margin of Lake Drummond 340
57. Salt marsh covered with *Spartina stricta maritima* 361
58. *Spartina stricta maritima* 362
59. Marram grass (*Ammophila arenaria*) on the dunes near Cape Henry, Va 369
60. Sea oats (*Uniola paniculata*) on the dunes near Cape Henry, Va 369
61. *Iva imbricata* on the dunes near Cape Henry, Va 370
62. Meadow-like growth of Ammophila near Oceanview, Va 371
63. Ammophila with *Myrica carolinensis* at Cape Henry, Va 371
64. Thicket of "myrtle" (*Myrica carolinensis*) on a dune at Cape Henry, Va 372
65. Live oak (*Quercus virginiana*) on the middle dunes near Oceanview, Va 373
66. *Pinus taeda* among the sand dunes near Oceanview, Va 374
67. *Panicum amarum* among the middle dunes near Cape Henry 375
68. *Panicum amarum* among the dunes near Oceanview, Va 376
69. *Hudsonia tomentosa* on the dunes near Virginia Beach (*Pinus taeda* in background) 377
70. Strand pine woods at Oceanview, Va 380
71. Innermost dunes encroaching on the strand pine woods (of *Pinus taeda*) near Virginia Beach, Va 381
72. *Diodia teres* on the middle dunes near Oceanview, Va., illustrating the radiant form 385
73. *Pinus taeda* along the Dismal Swamp Canal 397
74. Sweet gum (*Liquidambar styraciflua*) near Norfolk, Va 398
75. Sweet gum (*Liquidambar styraciflua*) at Wallaceton, Va 399
76. *Eupatorium capillifolium* on roadside near Wallaceton, Va 409
77. *Erianthus contortus* along a ditch near Portsmouth, Va 410
78. Rattan (*Berchemia scandens*) climbing on trees in the Black Gum Swamp 420
79. Mistletoe (*Phoradendron flavescens*) on a red maple 422
80. Forest of "juniper" (*Chamaecyparis thyoides*) on the margin of the Dismal Swamp 424
81. Trunk of "juniper" (*Chamaecyparis thyoides*) 425
82. Big cane (*Arundinaria macrosperma*) 427
83. *Erianthus saccharoides* on the eastern margin of the Dismal Swamp 438
84. *Cyperus erythrorhizos* along the Dismal Swamp Canal 441
85. Mouth of main drainage ditch emptying into the Dismal Swamp Canal, Wallaceton, Va 481
86. *Smilax laurifolia*, leaf in cross section 486
87. *Hypericum pilosum*, leaf 496
88. *Lechea maritima*, falsely bicellular hair from leaf 497
89. *Leucothoë axillaris*, lower surface of leaf showing stomata 499
90. *Galium hispidulum*, leaf 507

MAPS.

PLATE I. Map of northern Idaho .... **Frontispiece.**
MAP 1. Dismal Swamp district of Virginia and North Carolina 550
2. Norfolk Peninsula, showing fresh and salt water marshes, sand dunes, and uplands 550

NOV 20 1

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236

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